53
18
, Feb.

nce Abstracts

Section A

Physics Abstracts

UNIVERSITY OF ILLINOIS
LIBRARY
APR 18 1961
CHICAGO

Published by
ne Institution of
trical Engineers

Vol. 64 No. 758

February 1961 1628—2582

Physics Abstracts

Volume 64 FEBRUARY 1961 Number 758

CONTENTS

The monthly Author Index, List of Journals, Errata and Notes follow immediately after the last page of abstracts
For subscription rates, additional details, etc., see page iii of cover

RELATED SUBJECTS CONTAINED IN **Electrical Engineering Abstracts**

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Lines and networks
Waveguides
Transistors
Photocells
Thermionic tubes
Cathode ray tubes
X-ray tubes
Oscillators. Pulse circuits
Amplifiers
Electroacoustic apparatus
Radiocommunication
Mechanical engineering
Illumination

THE INSTITUTION OF ELECTRICAL ENGINEERS, SAVOY PLACE, LONDON W.C.2 © 1961

Ferranti

2½ MW S-Band Ferrite Isolator 2-C series

RATINGS AND CHARACTERISTICS

Range of centre frequencies:	2800-4000 Mc/s.
Bandwidth:	± 10% about the centre frequency.
Peak Power:*	2·5 MW.
Mean Power:*	3·5 KW.
Isolation at centre frequency:	Not less than 12 db.
Isolation over the band:	Not less than 9 db.
Insertion Loss:	0·5 db.
Input V.S.W.R.:	Less than 1·5
Mounting Position:	Any.
Weight:	30 lb.
Dimensions:	10½″ x 5⅞″ x 7½″.
Cooling:	Water.

*The power figures assume operation into a mismatch not worse than 2:1

FERRANTI LTD · KINGS CROSS ROAD · DUNDEE

Telephone: **DUNDEE 87141**

Ferranti

DS/T69

For modern techniques

PULSOMETER High Vacuum Gauges

PENNING-TYPE COLD CATHODE IONISATION GAUGE

- Pressure range 10^{-3} to 10^{-6} torr
- Robust design
- Portable or panel mounting
- Cannot be overloaded
- Energised when down to air without damage

Ideal for production work and general laboratory duties and for a wide variety of industrial purposes. In addition to its other applications the Gauge can be used to detect small leaks in systems.

Send for full details of this and other Pulsometer High Vacuum Plant.

THE PULSOMETER
HIGH VACUUM DIVISION
READING · BERKS
Telephone: Reading 67182

Publications of
THE INSTITUTION OF ELECTRICAL ENGINEERS

Journal of The Institution—Monthly

Proceedings of The Institution

PART A (Power Engineering)—Alternate Months
PART B (Electronic and Communication Engineering—including Radio Engineering)—Alternate Months
PART C (Institution Monographs)—In collected form twice a year

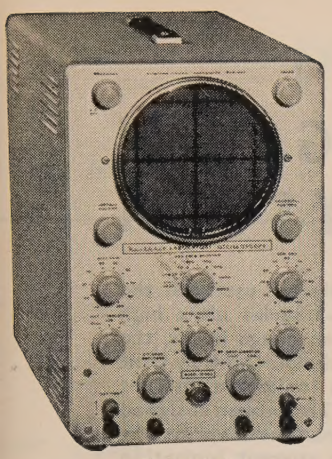
Special Issues

VOL. 94 (1947) PART IIA (Convention on Automatic Regulators and Servomechanisms)
VOL. 94 (1947) PART IIIA (Convention on Radiocommunication)
VOL. 97 (1950) PART IA (Convention on Electric Railway Traction)
VOL. 99 (1952) PART IIIA (Convention on the British Contribution to Television)
VOL. 100 (1953) PART IIA (Symposium of Papers on Insulating Materials)
Heaviside Centenary Volume (1950)
Thermionic Valves: the First 50 years (1955)
VOL. 103 (1956) PART B Supplements 1–3 (Convention on Digital-Computer Techniques)
VOL. 103 (1956) PART A Supplement 1 (Convention on Electrical Equipment for Aircraft)
VOL. 104 (1957) PART B Supplement 4 (Symposium on the Transatlantic Telephone Cable)
VOL. 104 (1957) PART B Supplements 5–7 (Convention on Ferrites)
VOL. 105 (1958) PART B Supplement 8 (Symposium on Long-Distance Propagation above 30 Mc/s)
VOL. 105 (1958) PART B Supplement 9 (Convention on Radio Aids to Aeronautical and Marine Navigation)
VOL. 105 (1958) PART B Supplements 10–12 (International Convention on Microwave Valves)
VOL. 105 (1958) PART C Supplement 1 (Position Control Massive Objects)
VOL. 106 (1959) PART A Supplement 2 (Convention on Thermonuclear Processes)
VOL. 106 (1959) PART B Supplement 13 (Convention on Long-Distance Transmission by Waveguide)
VOL. 106 (1959) PART B Supplement 14 (Convention on Stereophonic Sound Recording, Reproduction and Broadcasting)
VOL. 106 (1959) PART B Supplements 15–18 (International Convention on Transistors and Associated Semiconductor Devices)
VOL. 106 (1959) PART C Supplement 1 (Position Control of Massive Objects)
The Reliability and Maintenance of Digital-Computer Systems (1960)
VOL. 107 (1960) PART B Supplement 19 (Symposium on Data Handling and Display System for Air Traffic Control)
The Provision of Adequate Electrical Installations in Buildings.

Science Abstracts

Section A: Physics—Monthly Section B: Electrical Engineering—Monthly Cumulative Index

Prices of the above publications on application to the Secretary of The Institution, Savoy Place, W.C.2



Model O-12U
Oscilloscope

The kit-sets which give you the Best Possible Equipment at Absolutely Minimum Cost!

Heathkit
DAYSTROM

Examples are:—

5" FLAT-SCREEN OSCILLOSCOPE, Model O-12U
Laboratory instrument at utility 'scope price. Exceptionally wide-range time-base (10 c/s to 500 Kc/s) "Y" frequency range 3 c/s to over 5 Mc/s, sensitivity 10 mV RMS/cm. Electronically stabilised. Output for Wobbulator, Voltage Calibrator (1 volt pk to pk. source). Instantaneous shift, drift free. Automatic lock-in synch. Rise time 0 08μ secs or less. "Z" modn. facilities 2 gold-plated printed circuit boards and pre-cut cable wiring harness greatly facilitate assembly..... **£34.15.0**

OSCILLOSCOPE TRACE DOUBLER, ELECTRONIC SWITCH, Model S-3U
This extremely useful, low priced device will extend the use of your single-beam oscilloscope for duties otherwise only in the province of the double-beam tube. In short, at a nominal cost, the Heathkit model S-3U will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument. Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the 'scope itself. **£9.18.6**

PORTABLE 2½" SERVICE 'SCOPE, Model OS-1
The OS-1 uses a 2½" cathode ray tube and is a compact portable oscilloscope ideal for servicing and general laboratory work. Y amplifier sensitively 10m V/cm; response ± 3 dB 10 c/s-2.5 Mc/s. Time base 15 c/s–150 Kc/s. Features include Int. Ext. and 50 c/s sync; Sine sweep; time base output for wobbulator; X amplifier socket; 1, 10 and 50 volt calibrator. Uses printed circuit board for consistency and ease of assembly Case 7⅞" × 4¹⁵⁄₁₆" × 12½" long. Weight only 10½ lb. **£18.19.6**

VALVE VOLTMETER, Model V-7A. Because of the accuracy, reliability and sheer value of the Model V-7A it is outselling all other VVM's. The precision and quality of its first-class components cannot be duplicated elsewhere at this price. Indication is by a large 4½" 200 μA meter clearly calibrated for all ranges. The voltage divider networks use 1% precision resistors. A gold-plated printed-circuit board simplifies the assembly, saves time and eliminates the possibility of wiring errors. It also ensures duplication of laboratory performance. This multi-function VVM measures A.C. Volts (RMS and pk. to pk.), D.C. Volts and Resistance. The 7, A.C. (RMS) and D.C. ranges are 1.5, 5, 15, 50, 150, 500 and 1500. The 7, A.C. pk. to pk. Voltage ranges are 4, 14, 40, 140, 400, 1400 and 4000. D.C. input impedance is 11 MΩ. Seven Ohm-meter ranges have multiplying factors of XI, X10, X100, X1000, X10 K, X100 K and X1 MΩ. Centre-scale resistance readings are 10, 100, 1000, 10 K Ohms, 1 MΩ and 10 MΩ. A centre-zero dB scale is provided also for measuring audio amplifier performance. Test leads, prods and battery are included in the kit. **£13.0.0**
PROBES: R.F. **£1.5.6,** H.V. (30 kV d.c.) **£2.7.6.**

Audio Signal Generator, AG-9U. A high class audio generator covering a frequency range of 10 c/s to 100 Kc/s. Distortion is less than 0.1% between 20 c/s and 20 Kc/s. Frequency is selected by the two decade switches times the multiplier. Output constant over the whole frequency range approx. ± 1 dB and is variable from 3 mV f.s.d. to 10 V f.s.d. Output monitored by a 4½" panel mounted 200 μA., m.c. meter **£19.3.0**

Direct Reading Capacitance Meter, CM-1U. Measures 100 μ μF full scale to .1 μF full scale with complete accuracy. 1% external standards provided for each of the four ranges **£14.10.0**

Multimeter, MM-1U. Measures wide range of voltage, current, resistance and dB in over 20 ranges. Sensitivity 20,000 ohms/volt D.C. and 5000 ohms/volt A.C. 0–1·5, 1500 volts A.C. and D.C. 0–150 μA, 15 A D.C. Resistance 0.2 ohms to 20 megohms. 4½" meter, 50 μA f.s.d. **£11.8.6**

Audio-Millivoltmeter, AV-3U. An A.C. valve millivoltmeter having 10 ranges for measurement from 10 mV f.s.d. to 300 V f.s.d. Frequency response 10 c/s to 400 Kc/s ± 1 dB. Input resistance not less than 1 megohm. 4½" meter with 200 μA movement **£13.18.6**

Audio Wattmeter, AW-1U. Power range 5 mW—50 W f.s.d. Frequency response 10 c/s to 250 Kc/s ± 1 dB. Internal load resistors 3, 8, 15 and 600 ohms ± 1% non-inductive and switch selected. Power ratings 25 watts continuous, 50 watts intermittent. 4½" meter with 200 μA movement **£13.18.6**

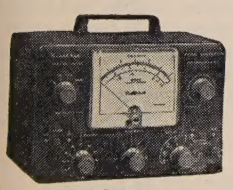
Power Supply Unit, MGP-1. Provides 3 D.C. outlets 250-300 V up to 90 mA., 170-220 V up to 30 mA, 150-200 V up to 10 mA and 6.3 V at 2.5 A A.C. **£4.9.0**

Decade Capacitance Box, DC-1. Precision 1% silver mica capacitors are used and switches are of the ceramic wafer type to ensure minimum loss. Three decades switches are used and cover a range of 100 pF to 0.111 μF in increments of 100 pF. **£5.18.6**

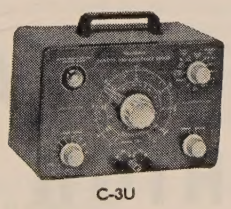
Resistance-Capacitance Bridge, C-3U. Resistance Capacitance Bridge measures capacitance up to 1000 μF and resistance up to 5 megohms. Also indicates leakage and provides a range of D.C. test voltages **£7.19.6**

Amplifier MA-12. A 10-12 watt high fidelity amplifier having extremely low distortion and wide frequency range. Generous auxiliary power supply provided .. **£9.19.6**

R.F. Signal Generator, RF-1U. Provides an accurate source of RF up to 100 Mc/s on fundamentals and 200 Mc/s on harmonics. Up to 100 mV output on all bands **£11.11.0**

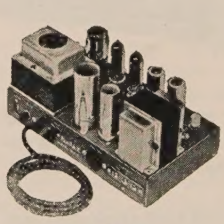


AG-9U

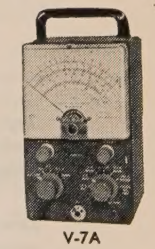


C-3U

S-3U



MA-12



V-7A

ALL AMERICAN KITS ARE NOW AVAILABLE (including Analogue Computers from £90 to £490)

Here are a few other examples:—

"Professional" 5" DC Oscilloscope, Model OP-1. Featuring a calibrated driven sweep with built-in triggering circuits, D.C. coupled vertical amplifier and a 5ADP2 flat-face CRT, the OP-1 offers professional performance at big savings **£95.0.0**

"General Research" 5" DC Oscilloscope, Model OR-1. An excellent read-out indicator in computer applications, as well as a versatile general service 'scope. Features identical D.C. coupled vertical amplifiers, 5ADP2 flat-face C.R.T, and transformer operated silicon diode power supply **£61.10.0**

"Q" Meter, Model QM-1. Measures inductance from 1 microhenry to 10 millihenrys, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf, ± 3 mmf vernier. Test coil for calibration and easy-to-follow instructions furnished **£28.10.0**

Harmonic Distortion Meter, Model HD-1. Measures harmonic distortion in amplifiers at frequencies between 20 and 20,000 CPS. Distortion ranges are 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges are 0-1, 3, 10 and 30 V Features high input impedance and 1% precision resistors. Ideal for use with Heathkit model AG-9U Audio Generator **£25.2.0**

Impedance Bridge, Model IB-2A. Wheatstone bridge, capacity comparison bridge, Maxwell bridge and a Hay bridge in one compact unit. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1 and storage factor (Q) from 0.1 to 1000. Built-in power supply, 1000 cycle generator and valve detector. Shpg. **£30.16.0**

We also recommend to you the American Heathkit **Transistorised Intercom Units** for use in the factory, office or home. The system consists of a master unit and up to 5 remote stations. .. .. XI-I Master Station **£14.3.0**; XIR-I Remote Station **£4.5.0**

N.B. Complete Catalogue of British HEATHKIT range and full details of any models gladly sent on request

DAYSTROM LTD

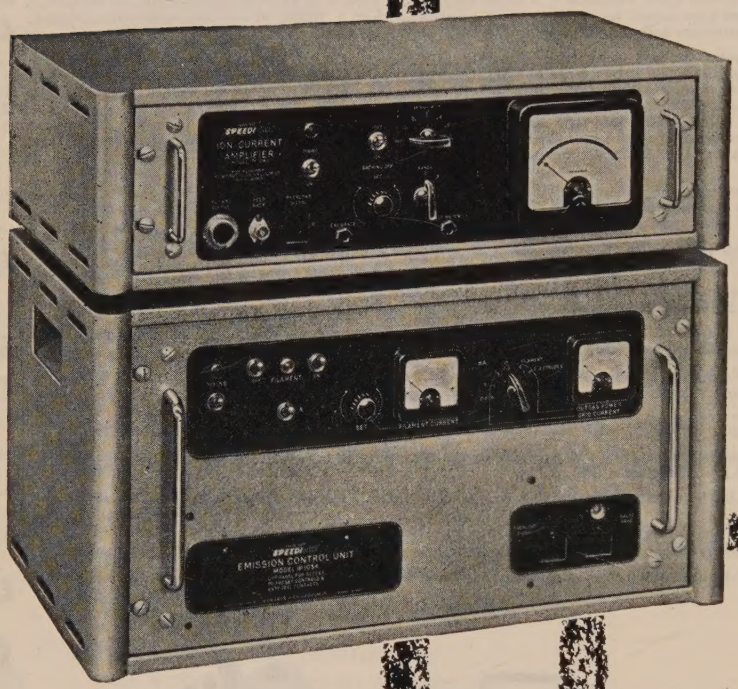
DEPT. SA2
GLOUCESTER

"SPEEDIVAC"

IONISATION GAUGE CONTROL SYSTEM

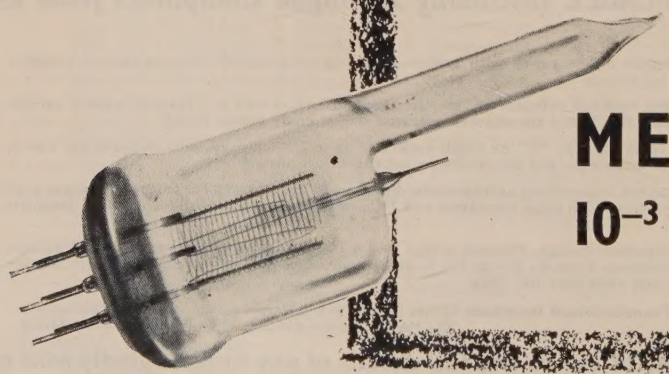
Intended basically for use with the "Speedivac" IG-3 series ultra high vacuum ionisation gauge heads, the "Speedivac" Emission Control Unit Model 1 and the Ionisation Current Amplifier Model 2 have been designed to provide also maximum versatility for general low current ionisation investigations, and other applications where emission controlled outputs and high sensitivity current indications are required.

The outstanding feature of this new ionisation gauge control system when used with an IG-3 gauge head is that pressures down to the soft x-ray limit, about 5 x 10^{-11} torr for this type of head, can be measured with only 10 μA emission current thus reducing to a new low level the risk of inaccuracy due to local ion pumping action by the gauge head. The extreme sensitivity of the "Speedivac" system permits nominal pressure changes of 5 x 10^{-13} torr to be indicated with the higher emission currents available.



Top: Ion current amplifier and emission control unit mounted together in standard 19" P.O. racks.

Lower: IG3H hard glass ultra high vacuum gauge head.



ULTRA-HIGH VACUUM MEASURING

10^{-3} to 5x10^{-11} torr

EDWARDS HIGH VACUUM LTD | MANOR ROYAL | CRAWLEY Crawley 1500 | SUSSEX | ENGLAND

PHYSICS ABSTRACTS

olume 64 FEBRUARY 1961 Number 758

ASTROPHYSICS

1628 RECENT STATISTICAL STUDIES IN ASTRONOMY. T.Page.
ience (USA), Vol. 132, 1870-5 (Dec. 23, 1960).

1629 INTERPRETATION OF COSMOLOGY. J.A.Bastin.
ture (GB), Vol. 188, 923-4 (Dec. 10, 1960).

The empirical difficulty of distinguishing between evolutionary d steady-state cosmology (Abstr. 16522, 18606 of 1960) is ex- ined in terms of the theories of inertia developed by the author ostr. 16569 of 1960) and others. Here the inertial mass of an ctron at any time depends on the overall matter density in the verse in such a way that the ratio (Hubble radius of universe/Bohr lius of atom) is time-independent. Consequently time-variations he Hubble radius are unobservable. F.A.E.Pirani

1630 A GENERAL DEDUCTION OF TWO IMPORTANT RELATIONS IN RELATIVISTIC COSMOLOGY. Raychaudhuri.
Astrophys. (Germany), Vol. 51, No. 2, 88-90 (1961).

Tolman (1934) deduced a relation for the change of radiation sity in the universe with time assuming the constancy of a cer- n function while Alpher et al (Abstr. 3024 of 1954) obtained a erent relation for the same change under the limiting circum- nce of extremely high density. Both these deductions were for tropic and homogeneous models. It is shown that the relations be obtained quite generally without the assumptions and approx- tions used by previous authors.

1631 ON THE OBSERVATION OF UNRESOLVED SURFACE FEATURES OF A PLANET. J.D.Isaacs and J.E.Tyler.
l. Astron. Soc. Pacific (USA), Vol. 72, 159-66 (June, 1960).

Models of planetary surfaces, incorporating three basic types idealized terrestrial relief features, are used in an attempt to in from carefully planned observing programmes reliable ntitative data for those major planets and asteroids that have gnizable surface features. Some specific problems related to observation of the planet Mars are discussed in the light of e idealized results. D.R.Barber

523.4

1632 A NEW INTERPRETATION OF MARTIAN PHENOMENA. C.C.Kiess, S.Karrer and H.K.Kiess.
l. Astron. Soc. Pacific (USA), Vol. 72, 256-67 (Aug., 1960).

All the available spectroscopic features of the Martian osphere can be simply explained by assuming it contains oxides itrogen. It is shown how the presence of these compounds can explain such features as the Martian polar caps and their urs, the seasonal colour changes in the dark areas and the ous cloud and haze formations. H.Morrison

1633 A SUGGESTED IMPROVEMENT TO THE C.W. TECHNIQUE FOR MEASUREMENT OF METEOR VELOCITIES. lainstone, W.G.Elford and A.A.Weiss.
al. J. Phys., Vol. 11, No. 2, 277-8 (June, 1958).

1634 ENERGY DISTRIBUTION IN THE GEGENSCHEIN SPECTRUM. N.N.Pariiskii and L.M.Gindilis.
n. Zh. (USSR), Vol. 36, No. 6, 1078-90 (1959). In Russian.
sh translation in: Soviet Astron.--AJ (USA), Vol. 3, No. 6, 1003 (May-June, 1960).

A detailed account of observations made for the first time of the nuous spectrum of the gegenschein (counterglow) near -Ata (USSR) at an altitude of 3000 m. The nebular spectrograph employed had great speed and adequate resolution. Elaborate auxiliary experiments were made to investigate various instrumental and other corrections that were required to eliminate the instrumental profile, and the effects of unwanted radiation scattered from the sky and other sources. Atmospheric extinction corrections were obtained from measures of the spectra of bright stars photographed with the same spectrograph; the spectrograms of the gegenschein were calibrated in absolute intensity units by exposure to a series of standard radioactive phosphors whose luminous output was accurately known. The spectral distribution of the gegenschein was found to be very similar to that of the zodiacal light at an angular distance of 40° from the sun, except for an excess of radiation in the region 4300 to 4500 A. The mean energy of emission was ~8.5% of that in the zodiacal light. Its absolute intensity varied between 5.5 and 1.0 erg cm^{-2} $sterad^{-1}$ ($\Delta\lambda$ = 1 cm) on normal nights; on anomalous nights, the intensity rose to as much as 25 in the same units. D.R.Barber

1635 THE ANNUAL VARIATION IN LATITUDE OF THE GEGENSCHEIN. L.M.Gindilis.
Astron. Zh. (USSR), Vol. 36, No. 6, 1091-3 (1959). In Russian.
English translation in: Soviet Astron.--AJ (USA), Vol. 3, No. 6, 1004-6 (May-June, 1960).

It is suggested here that the observed departure of the centre of the gegenschein from the plane of the ecliptic, and its sinusoidal latitude variation as a function of longitude, may arise from a superposition of two effects (1) emission from the zodiacal band with maximum at a position that varies sinusoidally with longitude; (2) emission of an entirely different nature with peak on the ecliptic, and which is probably associated with the earth's gaseous "tail". D.R.Barber

1636 THE GREAT METEOR OF 11th OCTOBER, 1960. D.S.Evans.
Monthly Notes Astron. Soc. S. Africa, Vol. 19, No. 10, 134-44 (1960).

A detailed summary of observations made in Transvaal, and at Cape Province, S. Africa. Height and bearing estimates show that the meteor first appeared at an altitude of ~100 miles travelling S to N. It exploded over a point ~20 miles E of Laingsburg when ~60 miles high, leaving behind a luminous cloud, 3-4 miles diameter. The "burn-out" occurred at an altitude of ~24 miles at a point ~8 miles SE of Sutherland. The angle of descent was ~45°, and the average velocity of flight ~40 miles/sec. D.R.Barber

1637 RECENT RE-ENTRY RESEARCH AND THE COSMIC ORIGIN OF TEKTITES. D.R.Chapman.
Nature (GB), Vol. 188, 353-5 (Oct. 29, 1960).

Some new results concerning the origin of tektites are obtained by applying recent advances from re-entry aerodynamics. It is concluded that the australite tektites show sufficiently clear and diverse indications of atmospheric entry to enable their approximate initial velocity and flight path angle to be determined. A surprisingly narrow band of entry velocity is delineated which is in that particular range uniquely compatible with origin from the moon. A.Boksenberg

1638 COMET 1959d (BESTER--HOFFMEISTER). C.Hoffmeister.
Observatory (GB), Vol. 80, 33-4 (Feb., 1960).

In reply to a criticism by Porter [Observatory (GB), Vol. 79, 160 (1959)], reasons are given for the delayed communication of Hoffmeister's results for this comet; and improved elements, together with an ephemeris for the period June-September, 1959, are included. D.R.Barber

1639 TEST FOR POLARIZATION IN THE INTEGRATED LIGHT OF SUNSPOTS. H.W.Babcock.
Publ. Astron. Soc. Pacific (USA), Vol. 72, 204-5 (June, 1960).

Using the Mt. Wilson solar magnetograph as a photometer, an entirely unsuccessful search was made for either circularly, or plane polarized light in the immediate vicinity of spot groups observed in white light. The tests were made with the 150 ft tower telescope on 29 January, 1960. No significant polarization of either type (≤1%) was found in the continuous spectrum of spots, and other active regions. D.R.Barber

1640 SOLAR ACTIVITY IN 1959. T.A.Cragg.
Publ. Astron. Soc. Pacific (USA), Vol. 72, 200-3 (June, 1960).

The total of 818 spot groups was the third highest recorded at Mt. Wilson Observatory. The N. hemisphere of the sun continued the more active with 569 groups, while the S. hemisphere had only 249, being the largest N-S excess ever recorded at Mt. Wilson. D.R.Barber

1641 ON THE THEORY OF SUNSPOTS. H.Alfvén.
Tellus (Sweden), Vol. 8, No. 2, 274-5 (May, 1956).

1642 ON THE LATITUDE DRIFT OF [SHORT-LIVED] SUNSPOT GROUPS. J.Tuominen.
Z. Astrophys (Germany), Vol. 51, No. 2, 91-4 (1961).

Studied separately for sunspot maxima and minima. The drift is shown to depend in a similar way on the latitude as, according to Becker (1954), is the case for long-lived groups. For the maxima, it is possible to interpret the drift as directed away from the centre of the spot zone. This is not so for the minima.

1643 SOLAR ACTIVITY AND GEOMAGNETIC STORMS, 1959. P.S.Laurie and H.F.Finch.
Observatory (GB), Vol. 80, 78-80 (Feb., 1960).

A summary of observations made at the Royal Greenwich Observatory (Hurstmonceux, and Hartland). Sunspot numbers in the second half of the year declined progressively, the mean daily number in October (106.5) being the lowest since January 1956. Flare activity was maintained, there being 13 class 3 events, and 4 class 3^+ events. Magnetic disturbance was comparable to that obtaining during the preceding 4 years. Fifteen active storms were recorded of which 5 were classed as "great" storms. D.R.Barber

THE ARCTIC IONOSPHERE AND SOLAR ACTIVITY. See Abstr. 1536

CORRELATION BETWEEN THE GEOMAGNETIC DISTURBANCES OF 1950 AND CALCIUM PLAGES. See Abstr. 1589

STATISTICS OF GEOMAGNETIC DISTURBANCES AND ACTIVE SOLAR REGIONS. See Abstr. 1590

THE PREDECREASE OF COSMIC RAYS IN PERIODS OF MAXIMUM SOLAR ACTIVITY (APRIL 1957 - DECEMBER 1958). See Abstr. 580

1644 STUDY OF THE FLARE-SURGE EVENT OF SEPTEMBER 7, 1958. K.M.Lowman and D.E.Billings.
Austral. J. Phys., Vol. 13, No. 3, 606-9 (Sept., 1960).

This surge belonged to the small class that are observed to remain bright against the solar disk over a prolonged period, but it was less bright than the parent flare. Two surges were photographed at the limb; one at 14 52 UT, the other at 14 55 UT. Details of their motions and velocities are given. Speeds of up to 520 km/sec were found, and moving material was under observation out to ~200 000 km from the solar limb. An approximate correspondence was noted between the optically-determined position of the front of the first surge, and the frequency of maximum emission in the simultaneous bursts of radio noise in the 100-560 Mc/s band recorded at 4 stations in N.America. From the collective results, electron densities between 4.2×10^8 and 1.9×10^8 cm^{-3}, at heights of 40 000, and 80 000 km, respectively, are deduced. These values correspond to a scale height of ~56 000 km above the chromosphere. D.R.Barber

1645 METHOD OF OBSERVING THE SOLAR CORONA AND JETS UP TO A GREAT HEIGHT. A.Dollfus.
C.R. Acad. Sci. (France), Vol. 247, No. 1, 42-4 (July 7, 1958). In French.

1646 THE CORONAL ACTIVITY OF 5 APRIL 1960. M.Waldmeier.
Z. Astrophys. (Germany), Vol. 51, No. 1, 1-10 (1960). In German.

Over the large sunspot group, which passed the western solar limb on 7 April 1960, the corona showed anomalously weak emissio lines and low density. Probably in connection with a flare, an inter sive coronal condensation occurred in this region on 5 April. It had a d tion of more than 10 hr, ascended with a velocity of about 2 km/sec an reached a height of 100 000 km at least. The condensation was accompanied by numerous sunspot-type prominences.

1647 THE FLARE OF 1957 SEPTEMBER 19. R.Jayanthan.
Observatory (GB), Vol. 79, 210-11 (Dec., 1959).

The spectrum of this class 2 flare recorded at 04h 09m - 1 mi before maximum activity - showed the Balmer H lines, and the Ca I and K lines in emission. All were widened asymmetrically, the widening being greater to the red. In a spectrum obtained 2 min later, the same lines showed only symmetrical broadening. If inter preted as a genuine Doppler effect, the earlier results for Hα, Hβ, and Hγ lines, suggest that matter was falling towards the photosphere with a mean velocity of 30 km/sec. D.R.Barbe

1648 THE LIMB FLARES OF OCTOBER 13, 1958. R.Hansen and D.Gordon.
Publ. Astron. Soc. Pacific (USA), Vol. 72, 194-9 (June, 1960).

Details are listed of the associated solar and ionospheric even of 13 October, 1958. Between 13h 47m and 22h 25m U.T. at least 5 distinctive flare groups occurred, of which three were uniquely correlated with intense and sudden cosmic noise absorptions (SCN D.R.Barb

1649 THE LINE AND CONTINUOUS EMISSION OBSERVED I TWO LIMB FLARES.
R.B.Dunn, J.T.Jefferies and F.Q.Orrall.
Observatory (GB), Vol. 80, 31-3 (Feb., 1960).

Spectrographic results for two bright limb flares in the 3600-3700 A region (dispersion 2A/mm) reveal electron temperatures derived from H line-widths that are consistently higher (2.6 to 11.0×10^4 °K) than those computed from absolute intensitie in the adjacent Balmer continuum (9.0 to 15.6×10^3 °K). The latt values correspond to electron densities of 0.9 to 1.5×10^{11} cm^{-3}. The cause of the discrepancy in the observed temperature is attributed to the blending of several emission components in each the broad Balmer line-profiles. These components originate fro relatively cool regions of the flare that have different sight-line velocities. D.R.Barb

1750 REPORT ON THE TOTAL ECLIPSE OF THE SUN, 2 OCTOBER 1959. H.von Klüber.
Naturwissenschaften (Germany), Vol. 47, No. 21, 481-6 (Nov., 196 In German.

The various programmes undertaken by eclipse expeditions from observatories and scientific institutions in Europe, and Ame operating in N. and W.Africa, are described. A useful series of charts is reproduced showing the location of the belt of totality fo the eclipses of 4-5 February, 1962, and 30 May, 1965. D.R.Barb

1651 THE SYSTEM OF VV CEPHEI. L.W.Fredrick.
Astron. J. (USA), Vol. 65, No. 10, 628-43 (Dec., 1960).

The system is studied by combining photometric, spectrosco and astrometric information. The absolute parallax is shown to b approximately 0".005. The inclination of the orbit is very nearly 90° and the size of the giant M component is of the order of 600 solar radii. Discrepancies between the spectroscopic data and th astrometric and photometric data are discussed and suggestions are made to explain or resolve the discrepancies.

1652 A LIST OF RELATIVELY COOL STARS IN THE VICINITY OF THE NORTH GALACTIC POLE. A.R.Upgren, Jr.
Astron. J. (USA), Vol. 65, No. 10, 644-7 (Dec., 1960).

In the course of a more extensive investigation of late-type stars in the vicinity of the north galactic pole, a number of relatively cool stars were found. The list of M and carbon stars pre pared for the present discussion contains the magnitude and spec tral class for each star and is probably complete to a photographi magnitude of 13.0 in an area of about 400 square degrees. A limi statistical study indicates that the ratio of dwarfs to giant stars t

s limiting magnitude in the area covered, is about one to three. neteen dwarf M stars were found. The space density of these arfs was found to be about 39 stars per 1000 cubic parsecs as ainst 36.3 per 1000 cubic parsecs for the known stars within five rsecs of the sun.

1653 IONIZATION AND EXCITATION OF NEUTRAL OXYGEN IN THE VICINITY OF HOT STARS. L.Houziaux.
Astrophys. (Germany), Vol. 51, No. 2, 95-106 (1961).

Relative populations of excited and ionized levels of oxygen are mputed. The investigated system includes a B2V star surrounded a spherical envelope, located at a distance of three stellar radii om the centre of the star. The envelope is opaque to the Lyman ntinuum and lines, but is transparent to the Balmer continuum. llowing transitions are considered: radiative transitions between screte levels, photoionizations, collisional excitations and ioniza- ns, and recombinations.

1654 DECAY OF SHOCK WAVES IN A STELLAR ATMOSPHERE. R.S.Kushwaha.
roc. Nat. Acad. Sci. India A, Vol. 29, Pt 1, 64-75 (1960).

The radial velocity variations of shock waves in a stellar mosphere are discussed. The approximation used neglects radia- on losses. It is assumed that the shock is produced below the otosphere. The predicted decay of the strength of the shock when mpared with the observations on BW Vulpeculae, shows disagree- ent.
M.Hasan

1655 PHOTOELECTRIC PHOTOMETRY OF GALACTIC AND EXTRAGALACTIC STAR CLUSTERS.
.E.Kron and N.U.Mayall.
stron. J. (USA), Vol. 65, No. 10, 581-620 (Dec., 1960).

Photoelectric observations are reported for 187 star clusters, ostly globular, in the Galaxy, Magellanic Clouds and the M31 group galaxies. All were observed in photographic and visual light, P nd V, and 117 in the infrared, I. Globular clusters in the Galaxy nd Clouds were measured through a series of apertures up to 25' ameter, to obtain total magnitudes and diameters containing 0.9 e total light. For comparison of integrated colours, 28 galactic en clusters were observed with apertures large enough to include ost of the cluster members. Some space-reddened F- and G-type pergiants having six-colour photometry were measured to obtain tal/selective absorption ratios of $A_V = (2.9 \pm 0.2) E(P-V) = .3 \pm 1.4) E(V-I)$. These ratios, with colour excesses estimated two ways from spectral types, were used to compute corrected al magnitudes, distance moduli and linear diameters for the lactic globular clusters. The principal results are: (1) The lactic globular and open clusters are generally well separated in e plot of (P-V) versus (V-I); (2) Linear diameters with 0.9 total ht range from 20 to 50 parsecs as M_V ranges from −6.8 to −9.6, t the scatter is so large that the correlation is not strong; Galactic globulars appear to be systematically bluer than M31 sters, by about 0.2 mag. in (P-V), notwithstanding uncertain owance for space reddening; (4) M31 clusters well outside the in spiral structure have an intrinsic colour range of 0.4 mag.; Except for a few relatively blue objects apparently like some in 3, the M31 clusters seen over the spiral have colours in the ge from (P-V) = +0.50 to +1.94 mag., with the reddest being ntest; (6) From eight M31 clusters that are brightest and reddest the V versus (P-V) plot, it was found that $A_V/E(P-V) = 0 \pm 0.14$, which is not regarded as significant of different absorb- matter in M31 than in the Galaxy; (7) Comparison of magnitude- quency histograms gave estimates of distance moduli ranging m 23.5 to 24.0 for M31 and 19 for the Magellanic Clouds, with all ues uncertain by 0.5 mag.; (8) The galactic centre distance was imated in two different ways at 12.5 and 12.0 kpc, with an un- tainty of about 1.5 kpc, on the assumption that for RR Lyrae iables $M_P = 0.0$.

1656 SPIRAL STRUCTURE OF THE GALAXY. A.J.Rutgers.
rwissenschaften (Germany), Vol. 47, No. 19, 440-1 (1960). erman.

An attempt is made to adapt Maxwell's theory of the stability aturn's rings to the problem of motion of stars in the Galaxy. criterion for dynamical stability is found not to be satisified, it is suggested that condensations formed along a galactic us would be distorted by differential rotation into a spiral arm.
R.A.Newing

1657 PLANETARY NEBULAE. M.J.Seaton.
Rep. Progr. Phys. (GB), Vol. 23, 313-54 (1960).

Planetary nebulae are gas clouds surrounding certain hot stars. The observational data are interpreted in terms of the process taking place in a low-density ionized gas exposed to dilute ultra-violet radiation. The aim is to obtain information about the density, kinetic temperature and chemical composition of the nebular material and about the nature of the ultraviolet radiation field.

Radioastronomy

1658 EVIDENCE FOR THE SOLAR CORPUSCULAR ORIGIN OF THE DECAMETER-WAVELENGTH RADIATION FROM JUPITER. T.D.Carr, A.G.Smith and H.Bollhagen.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 418-20 (Nov. 1, 1960).

There appears to be a correlation between the radio emissions from Jupiter and the geomagnetic activity at the time of Jovian opposition, suggesting that the radio emission is due to charged particles arriving from the sun. Explanations are suggested for the concentration of the noise source into one or more relatively narrow longitude zones which maintain the same rotational period for at least several years.
C.Hazard

1659 RELATION OF JUPITER'S RADIO EMISSION AT LONG WAVELENGTHS TO SOLAR ACTIVITY. J.W.Warwick.
Science (USA), Vol. 132, 1250-2 (Oct. 28, 1960).

Since the spring of 1960 a strong positive correlation between Jupiter's decametric emission and solar decametric continuum emission observed at Boulder has been evident. The time delay of 1 to 2 days, with solar emission preceding Jupiter's emission, suggests that fast solar corpuscles, at velocities of the order of 0.1 c, are directly involved in the planet's atmosphere or magnetic field.

1660 SIMILARITIES IN THE CHARACTERISTICS OF SOLAR RADIATION AT λ10.7 cm AND IN THE FAR ULTRA-VIOLET. C.M.Minnis and G.H.Bazzard.
Nature (GB), Vol. 181, 1796 (June 28, 1958).

1661 SCATTERING OF RADIO WAVES IN THE SOLAR CORONA AND CENTRE-LIMB VARIATIONS OF THE QUIET SUN METRE WAVELENGTH RADIATION. H.Scheffler.
Z. Astrophys. (Germany), Vol. 45, No. 2, 113 (1958). In German.

1662 NEW LIMITS TO THE DIAMETERS OF SOME RADIO SOURCES. L.R.Allen, H.P.Palmer and B.Rowson.
Nature (GB), Vol. 188, 731-2 (Nov. 26, 1960).

A preliminary account is given of measurements on 91 radio-sources using an interferometer with a base-line of 32 000 wavelengths and operating at a wavelength of 1.89 m. At least seven sources appear to have diameters less than 3 seconds of arc and surface temperatures comparable to that of the intense source in Cygnus I.A.U. 19N4A. One of these sources I.A.U. 14N5A was identified with an object having a recessional velocity approaching half the speed of light. This supports the view that sources of small angular diameter and surface temperatures comparable to Cygnus A are objects at such great distances that cosmological effects should be significant.
C.Hazard

Space Research

1663 EFFECT OF PRECESSION AND NUTATION ON THE ORBITAL ELEMENTS OF A CLOSE EARTH SATELLITE. Y.Kozai.
Astron. J. (USA), Vol. 65, No. 10, 621-3 (Dec., 1960).

Perturbations due to the motion of the equatorial plane of the earth are derived for the orbital elements of a close earth satellite. It is suggested that, for precise studies of satellite motion, a system be adopted in which the inclination and the argument of perigee are referred to the equator of date, and the longitude of the node is measured from a fixed point along a fixed plane and then along the equator of date.

1664 ON THE MOTION OF A SATELLITE IN THE VICINITY OF THE CRITICAL INCLINATION. B.Garfinkel.
Astron. J. (USA), Vol. 65, No. 10, 624-7 (Dec., 1960).

Treats the motion of a particle in the potential field

$$V = -1/r + J_2P_2(\sin\theta)/r^3 + J_4P_3(\sin\theta)/r^5$$

with J_2 and J_4 assumed to be small quantities of the first and the second orders, respectively, and with the value of the orbital inclination i lying in a neighbourhood of $\tan^{-1}2 \sim 63^0.4$. The method of attack is based on the removal of the short-periodic terms from the Hamiltonian by the von Zeipel method, followed by a Taylor series expansion of the energy integral up to quantities of the second order. As far as the Delaunay variables G', g' are concerned, the motion then becomes formally identical with that of a simple pendulum, and the solution is reduced to elliptic functions. In this form all the essential features of the motion are clearly revealed.

1665 EXPERIMENTAL INVESTIGATION IN LEAD OF THE WHIPPLE "METEOR BUMPER". A.E.Olshaker.
J. appl. Phys. (USA), Vol. 31, No. 12, 2118-20 (Dec., 1960).

Experimental results are presented to indicate the effects of a thin protective shield on reducing the penetration of simulated meteoroids. The study is mainly of lead impacting lead at 2.5 km/sec. The effects of thickness and separation of the shield are investigated. It is shown that a shield of thickness slightly less than half the projectile diameter at a separation of about five projectile diameters reduces the penetration of shield plus target to approximately one-third of the depth of the unshielded crater. This shield is also effective against hardened steel ball bearings. Based on the assumption that the "fluid impact" penetration mechanism of lead at this velocity is qualitatively similar to that of structural materials at meteor velocities, it is concluded that the weight savi potential of "bumper" construction will make its use mandatory fo space structures designed by the penetration condition.

1666 RADIO SCINTILLATIONS OF SATELLITE 1958α. O.B.Slee.
Nature (GB), Vol. 181, 1610-12 (June 7, 1958).

1667 EFFECT OF AIR DRAG ON THE ORBIT OF THE RUSSIAN EARTH SATELLITE 1957β: COMPARISON C THEORY AND OBSERVATION. D.G.King-Hele and D.C.M.Leslie.
Nature (GB), Vol. 181, 1761-2 (June 28, 1958).

1668 SOLUTION OF A DEGENERATE VARIATIONAL PROBLEM AND OPTIMAL CLIMB OF A SPACE ROCKET. V.A.Egorov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 16-26 (1958). In Russian.

A solution is given of Mayer's problem for Pfaff's equation with one free function, which is applicable to the selection of the trajectory of a rocket climbing to a given altitude with maximum speed. The general solution to the problem of rocket climb is investigated and applied to some special cases. The motion of a rocket on its ramp is also considered.

FADING OF SATELLITE TRANSMISSIONS AND IONOSPHER IRREGULARITIES. See Abstr. 1547

SCINTILLATIONS OF THE 20 Mc/s SIGNAL FROM THE EAR SATELLITE 1958 δ II. See Abstr. 1543

PHYSICS

GENERAL

1669 LIFE AND PHYSICAL DISCOVERIES OF TORRICELLI. Ya.G.Dorfman.
Uspekhi fiz. Nauk (SSSR), Vol. 66, No. 4, 653-69 (Dec., 1958). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 66 (1), No. 2, 276-86 (Nov.-Dec., 1958).

1670 ERROR ANALYSIS IN THE INTRODUCTORY PHYSICS LABORATORY. D.Moreno.
Amer. J. Phys., Vol. 28, No. 9, 786-90 (Dec., 1960).

Although most physics instructors agree that the analysis of error in a measurement is equally as important as the measurement itself, the matter is often neglected in the introductory laboratory. This neglect is frequently attributed to the belief that the relevant equations lie beyond the comprehension of the students. An elementary treatment of error is here presented in which it is shown that, at least in measurements involving simple functions, the propagation of error can be discussed using simple algebra. Two experiments are described as a basis for discussion.

1671 CURRENT TEACHING PRACTICES AND PROBLEMS IN THE GENERAL PHYSICS LABORATORY. H.Kruglak.
Amer. J. Phys., Vol. 28, No. 9, 791-3 (Dec., 1960).

Questionnaires on laboratory instruction were mailed to 1000 colleges in the USA. Frequency distributions of the 500 returns are given for length of laboratory period, instructional methods, evaluation techniques, enrollments, and pressing teaching problems. Separate analyses are made for schools offering a physics major and those not offering it.

1672 FURTHER COMMENT ON THE INTERRELATIONSHIP OF PHYSICAL QUANTITIES. K.G.McNeill.
Amer. J. Phys. (USA), Vol. 28, No. 8, 744 (Nov., 1960).
See Abstr. 4924, 18899 of 1960.

1673 A SURVEY OF THE SYSTEMATIC EVALUATION OF THE UNIVERSAL PHYSICAL CONSTANTS. R.T.Birge.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 39-67 (1957).

Historical survey, and summary of some of the author's methods of approach, with particular reference to the constants e, c, N, a α. 65 refs. J.Hawg

1674 PRESENT SOURCES OF PRECISE INFORMATION O THE UNIVERSAL PHYSICAL CONSTANTS. J.W.M.DuMond.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 68-109 (1957).

Describes in careful detail the group of accurate experiment used as the source of input data for the calculations determining constants, and their inter-relationships. 71 refs. J.Hawg

1675 MATHEMATICAL ANALYSIS OF THE UNIVERSAL PHYSICAL CONSTANTS. E.R.Cohen.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 110-40 (1957).

Description of the numerical techniques used, and the results obtained, in the 1955 calculations of the best values of the constan J.Hawg

1676 PRESENT STATUS OF RESEARCH ON THE PHYSICA CONSTANTS AT THE (UNITED STATES) NATIONAL BUREAU OF STANDARDS. R.D.Huntoon and A.G.McNish.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 146-84 (1957).

A careful review of the precision with which the present prim and derived standards, and the physical constants which may bec the basis for new standards, can be measured, and of work at the N.B.S. in this connection. 45 refs. J.Hawg

1677 A NEW DETERMINATION OF AVOGADRO'S NUMBE FROM LATTICE CONSTANT AND DENSITY OF SIN CRYSTALS. A.Smakula and J.Kalnajs.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 214-20 (1957).

Measurements on Al, CaF_2, Ge, Si and SiO_2 were used to determine a new value for the constant of $(6.023\,68 \pm 0.000\,02) \times \times 10^{23}$ mole^{-1} on the chemical scale [$(6.025\,36 \pm 0.000\,02) \times \times 10^{23}$ mole^{-1} on the physical scale]. It is claimed that this valu is in good agreement with that obtained by Birge (Abstr. 2289 of 1945) when certain of the data used by him are rejected owing to unreliability and when account is taken of alterations in the acce values for the conversion factors. J.W.Le

1678 A NOTE ON THE DETERMINATION OF THE AVOGADRO NUMBER. N.W.H.Addink.
uovo Cimento Suppl. (Italy), Vol. 6, No. 1, 221-3 (1957).
In a previous paper (Abstr. 3904 of 1951) the author determined vogadro's number from measurements of density and lattice con-ant using various "ideal" crystals. Observations made on certain her crystals (PbO, KCl, etc.), were held to relate to "imperfect" rystals. The present paper gives reasons for regarding these rystals as imperfect. J.W.Leech

SURVEY OF ATOMIC CONSTANTS. See Abstr. 787

1679 GRAVITATIONAL AND INERTIAL MASS. H.Lustig.
mer. J. Phys., Vol. 28, No. 9, 820 (Dec., 1960).
Comments on a paper by G.B.Brown (Abstr. 6641 of 1960).

1680 REPLY TO LUSTIG'S COMMENTS. G.B.Brown.
mer. J. Phys., Vol. 28, No. 9, 820 (Dec., 1960).

1681 HYPOTHESIS OF CALCULABILITY. P.Renaud.
.R. Acad. Sci. (France), Vol. 251, No. 15, 1465-7 (Oct. 10, 1960).
n French.

GRAVITATION . RELATIVITY

1682 THEORY OF GRAVITATIONAL PERTURBATIONS IN THE FAST MOTION APPROXIMATION. .Bertotti and J.Plebanski.
nn. Phys. (USA), Vol. 11, No. 2, 169-200 (Oct., 1960).
The Green's function method, classical for a linear wave equation, is generalized to a nonlinear field theory and, specifically, to eneral relativity. The general structure of a Lorentz-invariant erturbation expansion in terms of the gravitational constant is udied. It is found that the n-th order contribution can be expressed ith the help of a set of generalized Green's functions, depending n events on the "sources" and the event at which the field is anted. The "sources" include not only the ordinary matter, but so the initial conditions which are prescribed to the metric field determine it uniquely. The generalized Green's functions are udied with the help of a graphical representation which makes ear how the nonlinearity of the equations affects the propagation gravitational action. Its "scattering" by the sources and by the ld itself produces the result that every event inside the light cone y contribute to the force on a particle at its vertex; the equations motion have therefore an integro-differential structure. The neral formalism is applied to the second approximation; the equations of motion, with an accuracy up to the second order, and levant generalized Green's function are computed.

1683 THE GENERAL FORM OF THE PROPAGATION LAW OF GRAVITATIONAL SHOCK-FRONTS. H.Treder.
n. Phys. (Germany), Vol. 6, No. 5-6, 307-10 (1960). In German.
The shock front comprises discontinuities in the nth derivatives he metric tensor across a (null) hypersurface in vacuum. The pagation law is formulated in a way independent of any special resentation of this hypersurface; this generalizes results of llmacher (Mathematische Annalen, Vol. 115, 741 (1939); cf. tr. 3094 of 1959). F.A.E.Pirani

1684 QUANTUM LIMITATIONS OF MACH'S PRINCIPLE. A.Peres.
l. Res. Coun. Israel, Vol. 9F, No. 2, 71-4 (Nov., 1960).
It is shown that the quantum uncertainty of the angular momen- and angular position of a rotator causes an uncertainty in its vitational field, which grows to infinite values at very large ances from the rotator. It is thereby inferred that a finite ribution of matter can determine which frames are inertial only in a finite distance. Cosmological consequences of this fact briefly discussed.

1685 A SOLUTION OF THE EINSTEIN FIELD EQUATIONS. P.Rastall.
d. J. Phys., Vol. 38, No. 12, 1661-4 (Dec., 1960).
An exact, cylindrically symmetric, time-dependent solution of the Einstein gravitational field equations for empty space is derived. A particular case of the solution has singularities only on the axis of symmetry and may represent a number of particles in an otherwise empty universe.

1686 CLASSIFICATION OF GRAVITATIONAL RADIATION. J.Weber and D.Zipoy.
Nuovo Cimento (Italy), Vol. 18, No. 1, 191-2 (Oct. 1, 1960).
A gravitational field is called "locally plane" at a point if geodesic coordinates with that point as origin may chosen so that $g_{mn,r_2} = g_{mn,r_3} = 0$ there (m,n.r = 1,2,3,4). It is shown that a locally plane vacuum gravitational field must be of Petrov type N. F.A.E.Pirani

1687 NOON—MIDNIGHT RED SHIFT. B.Hoffmann.
Phys. Rev. (USA), Vol. 121, No. 1, 337-42 (Jan. 1, 1961).
A terrestrial atomic clock at noon can be some 10^9 cm nearer the sun than an antipodal clock at midnight. The difference in gravitational potential due to the sun corresponds to a difference of time rates corresponding to a red shift $\Delta\nu/\nu = 8 \times 10^{-13}$. But this red shift is almost exactly cancelled by a violet shift arising from the relativistic Doppler effect, so that the resultant shift is essentially zero. If the earth shielded or focused the solar gravitational field, the gravitational contribution to the red shift would be altered and one might expect a resultant shift. But the motional contribution to the shift is also altered and, except for unrealistically large shielding or focusing, the resultant shift would still be zero. However, all this is true only if the principle of equivalence is valid. The Pound--Rebka experiment (Abstr. 10570 of 1960) confirms its local validity with a 10% accuracy. A 10% discrepancy could imply a noon—midnight red shift $\Delta\nu/\nu = 8 \times 10^{-14}$, compared with 5×10^{-16} in the Pound—Rebka experiment. Moreover, since the solar gravitational contribution to the value of g is only 5×10^{-4} g, the Pound—Rebka experiment is insensitive to solar effects and would not detect possible anomalies arising from shielding or focusing by the earth of the locally almost uniform solar gravitational field which might nevertheless affect the noon—midnight shift. Detection of a significant noon--midnight shift would be a disproof of the general theory of relativity.

1688 TEMPORAL REVERSAL OF EVENTS IN RESTRICTED RELATIVITY. C.W.Berenda.
Amer. J. Phys., Vol. 28, No. 9, 799-801 (Dec., 1960).
A simple "scissorlike" effect is mathematically examined as a measurable process that can produce over-light speeds of the intersectional point. This process is studied under the conditions of restricted relativity theory, and it is shown that when the intersectional point exceeds light speed c in one inertial system S, it can undergo "temporal reversal" relative to some other inertial system S'.

1689 ABERRATION OF PLANE WAVES. E.F.Fahy.
Nature (GB), Vol. 188, 396-7 (Oct. 29, 1960).
Aberration due to motion of the observer is calculated, according to special relativity, for plane waves of arbitrary velocity, and the result contrasted with its Newtonian analogue. F.A.E.Pirani

1690 SPACE—TIMES OF PETROV TYPE III. R.Debever.
C.R. Acad. Sci. (France), Vol. 251, No. 14, 1352-3 (Oct. 3, 1960). In French.
Conditions are found for the metric

$$ds^2 = e^{2\alpha}\{(dx^2)^2 + (dx^3)^2\} + 2dx^4\{dx^1 + Cdx^4\}$$

(where α is a function of x^2, x^3, x^4, and C of all the coordinates) to be that of a null electromagnetic field, or of free space; and such metrics are of Petrov type III. C.W.Kilmister

1691 A HEURISTIC APPROACH TO GENERAL RELATIVITY. H.Hönl, H.Dehnen and K.Westpfahl.
Ann. Phys. (Germany), Vol. 6, No. 7-8, 370-406 (1960). In German.
The physical significance of general relativity is exhibited by heuristic arguments which avoid appeal to general covariance. [It is impossible to summarize, but the discussion can be recommended to those who seek such a clarification].
C.W.Kilmister

1692 AN INTERPRETATION OF THE LORENTZ TRANSFORMNAIAOTINT TOTNT TOTITNT TITNIOTINTITO

J. Roy. Soc. New S. Wales (Australia), Vol. 94, Pt 3, 109-13 (1960).

It was shown in a previous paper (Abstr. 10575 of 1960) that Einstein's principles and definitions are consistent with a new interpretation regarding the measurement of time in Special Relativity. An extension of the argument to space-interval measurements leads to a fully consistent interpretation of the Lorentz transformation and the co-ordinates involved therein. The approach gives physical meaning to the reciprocity property of the transformation and suggests a criterion of simultaneity for observers in relative motion. It is suggested that the transformation may have a previously unsuspected bearing on a number of practical and theoretical issues including radar measurements and the nature of light transmission.

1693 EQUIVALENCE PRINCIPLE AND RED-SHIFT MEASUREMENTS. A.Schild.

Amer. J. Phys., Vol. 28, No. 9, 778-80 (Dec., 1960).

Two questions are discussed. The first asks whether experiments on accelerated systems (e.g. red-shifts produced in rotating disks) can serve to verify the general theory of relativity. The answer is "no". The second asks to what extent the special theory of relativity and the principle of equivalence determine the well-known effects of the general theory of relativity. It is important to formulate this question very carefully because special relativity and the equivalence principle do not form a consistent theoretical system. If this is done, then the answer is that the equivalence principle leads to the same gravitational red-shift as general relativity but does not lead to specific values for the bending of light rays by a star or for the perihelion rotation of a planetary orbit.

1694 THE FIELD OF AN ELECTRIC CURRENT IN GENERAL RELATIVITY. W.B.Bonnor.

Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 891-9 (Dec. 1, 1960).

The amount of gravitational mass contributed by electromagnetic energy is not clear from previous investigations. In the case of the exterior field of a charged sphere, the charge appears not to contribute at all to the gravitational mass, but other electrostatic and magnetostatic fields give different results. The field of a circular wire carrying a steady current is investigated by the theory of relativity. An exact solution is obtained for a wire without mass, but this contains a singular surface without physical significance. An approximate solution without this singularity is then obtained, and this shows that the energy of the magnetic field generated by the current contributes to the gravitational mass of the system. The order of magnitude of the effect is discussed with a view to its experimental detection.

1695 STUDY OF THE JORDAN–THIRY THEORY IN THE PURELY GRAVITATIONAL CASE IN WHICH THE MATTER IS UNCHARGED. A.Surin.

C.R. Acad. Sci. (France), Vol. 251, No. 13, 1270-2 (Sept. 26, 1960). In French.

A 4-space is defined by the metric $g_{ij} = \gamma_{ij} - (\gamma_{io}\gamma_{jo}/\gamma_{oo})$, where $\gamma_{\alpha\beta}$ is the metric of 5-space. It is shown that in the purely gravitational case, to a second-order approximation g_{ij} cannot be conformally equivalent to the metric of general relativity.

R.A.Newing

1696 A NEW FORM FOR THE CONSERVATION IDENTITIES IN UNIFIED FIELD THEORY. S.Kichenassamy.

C.R. Acad. Sci. (France), Vol. 251, No. 14, 1349-51 (Oct. 3, 1960). In French.

Space–time is endowed with a tensor field $g_{\alpha\beta}$, an affine connection $L^{\lambda}_{\mu\nu}$ with zero torsion, and a vector field $\Gamma\rho$. Known conservation identities are derived from variational principles, without recourse to equations of linear displacement, for a variety of unified theories. F.A.E.Pirani

1697 DIFFERENTIAL INVARIANTS OF A MAXWELL FIELD. J.Romain.

C.R. Acad. Sci. (France), Vol. 251, No. 19, 1975-7 (Nov. 7, 1960). In French.

Twenty four first-order differential invariants can be constructed from the space-time metric tensor and an arbitrary skew-symmetric tensor ϕ_{ij}. It is shown that there is only one non-null, linearly independent invariant when space-time is Minkowskian and ϕ_{ij} defines an electromagnetic wave; the invariant is given a geometrical interpretation in this case. R.A.Newing

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

1698 LIMIT OF A ONE-DIMENSIONAL SQUARE WELL. J.G.Brennan.

Amer. J. Phys., Vol. 29, No. 1, 45-7 (Jan., 1961).

A wave function which represents a decaying exponential in a space is shown to be the limiting solution to a one-dimensional square well potential problem. If the limit is defined properly, th expectation value of the kinetic energy is shown to be positive definite.

1699 THE THEORY OF SYSTEMS OF PARTICLES IN THE CAUSAL INTERPRETATION OF WAVE MECHANICS. J.Andrade e Silva.

Ann. Inst. Poincare (France), Vol. 16, No. 4, 289-359 (1960). In French.

Detailed description of theory extending de Broglie's ideas to systems of particles; in particular, it is shown how to write the equations in 3-dimensional instead of in 3N-dimensional space, a how to introduce statistical randomness into the causal interpret J.Hawg

1700 ON THE STABILITY OF DYNAMICAL SYSTEMS AND SCHRÖDINGER'S EQUATION. ON THE PASSAGE FR GEOMETRICAL OPTICS TO WAVE OPTICS. N.Chako.

C.R.Acad. Sci. (France), Vol. 251, No. 5, 645-7 (Aug. 1); No. 6, 852-3 (Aug. 8, 1960). In French.

Poincaré's theorem is the basis for the argument deriving wa mechanics from classical mechanics in the first note. In the sec a similar argument is applied to optics. J.Hawg

1701 ON THE INTERPRETATION OF QUANTUM MECHANICS. UNCERTAINTY RELATIONS. A.Datz

C.R.Acad. Sci (France), Vol. 251, No. 15, 1462-4 (Oct. 10, 1960). In French.

See Abstr. 17212 of 1960. In previous articles a mathematic formalization of quantum mechanics was drawn up. The author now shows that this does not lead to the orthodox interpretation o the uncertainty relations but indicates they have only a probabal- istic meaning. H.Morris

1702 SIMPLIFIED SELF-CONSISTENT FIELD EQUATIONS WITH CORRELATIONS. S.Olszewski.

Phys. Rev. (USA), Vol. 121, No. 1, 42-5 (Jan. 1, 1961).

It is pointed out that the correlation hole has, qualititatively, features analogous to the exchange one; and to the correlation, th corresponds a potential of the conventional electrical character. One can further obtain — in the case of the free-electron gas — t correlation potential averaged over all the electron states, in clo correspondence with the averaged exchange potential of Slater. I further reasonable to use this potential as the averaged correlati potential of the arbitrary many-electron system where the densit the free-electron gas is replaced by the density of actual charge the system. Adding the averaged correlation potential as well as averaged exchange correlation potential to the Hartree–Fock ope tors, one obtains the self-consistent field equations with correlat

STATISTICAL MECHANICS TRANSFER PROCESSES

1703 ON A CERTAIN PROBLEM OF STOCHASTIC BODIE WITH DISCONTINUOUSLY NON-HOMOGENEOUS PROPERTIES. J.Litwiniszyn.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 12, 673-8 (1959).

1704 PROPERTIES OF LINEAR COLLISION OPERATORS. IMPERFECT LORENTZ GASES. J.Naze.
. Acad. Sci. (France), Vol. 251, No. 21, 2284-6 (Nov. 21, 1960).
rench.
Continuing the work of two previous papers (Abstr. 18978, 19191 960) the eigenvalues of the Lorentz collision operator are evalu- in certain special cases. H.N.V.Temperley

1705 ON THE STATISTICAL THEORY OF NON-LINEAR FIELDS. Ya.P.Terletskii.
l. Akad. Nauk SSSR, Vol. 133, No. 3, 568-71 (July 21, 1960). In sian.
It is assumed that a classical field obeys equations of motion ch can be derived by the Lagrangian formalism. A generalized se space is introduced so that every point corresponds to a nite space–time function representing the field. Probability ributions are formulated which virtually exclude any violation of equations of motion. These distributions are shown to have forms ilar to the familiar distribution functions of statistical mechanics. author says that this formalism is free from mathematical in- sistency provided that the equations of motion are non-linear. ng this formalism and appealing to Feynman's space–time roach to quantum mechanics, the author establishes an analogy veen the equations of quantum theory and of classical statistical hanics. Here it is necessary to replace the temperature by an ginary quantity. [English translation in: Soviet Physics–Doklady A)]. R.Eisenschitz

1706 ON THE DEVELOPMENT OF THE GRAND PARTITION FUNCTION FOR SYSTEMS OF IDENTICAL PARTICLES.
Gaudin.
lear Phys (Internat.), Vol. 20, No. 4, 513-32 (Nov. (3), 1960).
rench.
Starting from the perturbation expansion of the grand partition tion, the general n^{th} order term is described by a pair of two mutations and its contribution is presented in a compact form of m of n^{th} order permanents. The procedure is applied to a tem of fermions interacting via a two-body separable potential. form of the series suggests a partial summation which gives known result for the thermodynamic potential in the supercon- ting state.

1707 PROCEEDINGS OF THE INTERNATIONAL CONGRESS ON MANY-PARTICLE PROBLEMS.
pl. to Physica (Netherlands), Vol. 26, S1-S217 (Dec. 26, 1960).
The congress was held at Utrecht, June 13-18, 1960, and was anized by the Netherlands Physical Society. The volume contains nain papers and 5 discussion remarks. Abstracts of the main ers will appear in this or subsequent issues of "Physics Abstracts".

708 ON THE SUMMATION OF GENERALIZED LADDERS FOR A MANY-FERMION SYSTEM. M.L.Mehta.
lear Phys. (Internat.), Vol. 20, No. 4, 533-42 (Nov. (3), 1960).
The analogy between an interacting fermion system and a system n external potential, which may be non-hermitian, is employed ow why the generalized ladder approximation for an interaction active near the Fermi-surface diverges.

709 APPROACH TO EQUILIBRIUM IN QUANTUM SYSTEMS. P.Résibois.
. Rev. Letters (USA), Vol. 5, No. 9, 411-13 (Nov. 1, 1960).
In earlier work from the Belgian school the Liouville equation erturbation techniques were used to discuss the approach to ibrium in classical statistical mechanics. This letter indicates tension to quantum systems. It suggests that very similar dures may be applicable for equilibrium and non-equilibrium ems in classical and quantum mechanics. P.T.Landsberg

710 THE DISCONTINUITIES IN THE SOLUTIONS OF THE TRANSPORT EQUATION AND THE VARIATIONAL CIPLE. R.Englman.
. Phys. Soc. (GB), Vol. 76, Pt 6, 909-13 (Dec. 1, 1960).
A corrected proof is given of the result of Garcia-Moliner and ns (Abstr. 5470 of 1958) showing the equivalence of the varia- l formulation and the transport (Boltzmann) equation in the of an applied magnetic field and effective crystal boundaries in s. The proof in the present paper takes into account the nce of a hyper-surface (in phase-space) of discontinuities of stribution function.

1711 THE RELAXATION OF SYSTEMS OF PERMANENTLY POLARIZED MICROSYSTEMS, IN A STRONG EXTERNAL FIELD. M.Mugur.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 3, 311-19 (1957). In Roumanian.
It is shown that the relaxation equation, in a strong external field, of a system of permanently polarized microsystems can be expressed in a form consistent with a new possible model of the relaxation mechanism — provided that the difference between the transition probability of an individual microsystem, from a given state to another one of a lower energy, and the probability of the reverse transition, be independent of the lattice temperature. This model may suggest new ways of experimentation in the study of nuclear or microstructural characteristics and it may have applications in the general theory of irreversible processes. Another result is an expression of the equilibrium distribution of the microsystems and of the equilibrium susceptibility of the system, as a function of the transition probabilities of individual microsystems.

BROWNIAN MOTION IN NONLINEAR SYSTEMS. APPLICATION TO CAPACITOR--DIODE CIRCUITS. See Abstr. 1883

GENERAL MECHANICS

1712 ORTHOGONAL EDGE POLYNOMIALS IN THE VARIATIONAL SOLUTIONS OF SOME BOUNDARY LAYER PROBLEMS IN ELASTICITY. G.Horvay.
Z. angew. Math. Phys. (Switzerland), Vol. 11, No. 2, 102-16 (March 25, 1960).
A theoretical study is made of the problem of a semi-infinite strip having nonhomogeneous boundary conditions along one edge and homogeneous boundary conditions along the other edges. The ordinary techniques of Fourier series are difficult to apply in such a case and a variational method is developed which produces, at a modest sacrifice in accuracy, a product function behaviour for the biharmonic eigenfunctions. Several cases are studied and the derivatives obtained by the new method are compared with the rigorously orthogonal functions and found reasonably satisfactory. The problems examined include the cylinder end case and a Legendre polynomial. A.C.Whiffin

1713 IMPROVEMENTS OF PHOTOELASTIC TECHNIQUE FOR STRAIN MEASUREMENT ON FLAT SURFACES. G.Clyne, H.Fessler and R.W.Wilson.
Brit. J. appl. Phys., Vol. 12, No. 1, 8-10 (Jan., 1961).
The use of the impact glue, Eastman 910, produced stronger bonds than could be achieved with epoxy resin adhesives. Epoxy resin layers bonded on to flat polished Dural surfaces were torn by fatigue cracks in the metal without extensive bond failure. The bond strength was improved by controlled etching and hot soaking of the Dural surface (as shown by Fessler and Haines in Abstr. 5668 of 1958) before bonding. Impact glue bonds between epoxy resin layers and flat polished alloy steel surfaces withstood static strains of 0.3% (slightly beyond yielding) in pure tension and 2.5% in eccentric tension.

1714 A HINGED THIN SHALLOW SPHERICAL SHELL RECTANGULAR IN THE HORIZONTAL PROJECTION. B.Ławruk.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 413-18 (1959).

1715 BENDING OF CURVILINEAR AND RECTILINEAR POLYGONAL PLATES SYMMETRICALLY LOADED OVER A CONCENTRIC CIRCLE. W.A.Bassali and N.O.M.Hanna.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 166-79 (Jan., 1961).
Complex variable methods are applied to obtain exact solutions for the complex potentials and deflections of thin isotropic slabs bounded by regular curvilinear polygonal contours with n sides and subject to symmetrical loading distributed over a concentric circle. The supported boundary is either clamped or has equal boundary cross-couples. The plates taken in the z-plane are conformally

mapped on the unit circle in the ζ-plane by the mapping function

$$z = c\zeta \sum_{\nu=0}^{m} \lambda_\nu \zeta^{\nu n} \quad (c > 0, \lambda_0 = 1).$$

Polynomial approximations to the Schwarz–Christoffel transformations are then used to discuss the bending of clamped and simply supported rectilinear plates symmetrically loaded over a concentric circle or acted upon by a central point load.

GENERAL EXPRESSIONS FOR THE BOUNDARY CONDITIONS OF EQUILIBRIUM OF AN ANISOTROPIC INHOMOGENEOUS PLATE. See Abstr. 185

1716 THERMOELASTIC PROBLEM FOR A WEDGE. W.Piechocki and H.Zorski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 10, 555-65 (1959).

1717 THERMOELASTIC PROBLEM FOR AN ISOTROPIC SPHERE WITH TEMPERATURE DEPENDENT PROPERTIES. J.Nowinski.
Z. angew. Math. Phys. (Switzerland), Vol. 10, No. 6, 565-75 (1959).

General formulae suitable for numerical computation are obtained for the displacement and stress in a solid or hollow spherically symmetric incompressible body in which the elastic moduli and coefficient of expansion vary with temperature, and in which the temperature is a function of radial distance from the centre of symmetry. J.G.Oldroyd

1718 EXPERIMENTAL SELF-PLOTTING OF TRAJECTORIES. R.M.Sutton.
Amer. J. Phys., Vol. 28, No. 9, 805-7 (Dec., 1960).

A ball is rolled repeatedly down an incline and launched in free flight in a vertical plane. It strikes a vertical drawing board set perpendicular to the plane of flight and records each point of striking by means of carbon paper on white. The board is moved farther and farther from point of launching of ball and at same time laterally by equal amounts. Thus a curve which lies in xy plane is made to record points in yz plane. In a short time, good curve of trajectory is obtained and then compared with theoretical curve fitted to origin, highest point, and range. Unexpectedly, the experiment is not sensitive to g, so would lead to exactly the same curve on moon or Mars.

1719 ELEMENTARY ANALYSIS OF THE GYROSCOPE. E.F.Barker.
Amer. J. Phys., Vol. 28, No. 9, 808-10 (Dec., 1960).

The simple gyroscope is an excellent subject for a lecture table demonstration to classes in elementary physics. The only observable force acting upon the precessing top is a downward pull due to gravity, yet, instead of falling, it moves with a continuous horizontal displacement. An adequate and convincing explanation of this curious behaviour is essential, and it must be stated in language familiar to the student. One possible approach to the problem, using a very simple model, is given. The internal reactions are described and their values are computed. Because of some difficulty in visualizing motion in three dimensions, it is recommended that a model be constructed.

1720 GENERAL SOLUTIONS OF THE CONSERVATION EQUATIONS IN CURVED SPACES. H.Zorski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 10, 567-71 (1959).

1721 SPECIAL CASE OF THE EXISTENCE OF SMALL PERIODIC MOVEMENTS OF TWO PENDULUMS SUBJECTED TO UNIFORM ROTATION. S.Manolov.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 139-42 (1958). In Russian.

Two pendulums are suspended from a common horizontal axis which is rotating uniformly about a vertical axis. It is shown that, under suitable initial conditions, small periodic oscillations about the vertical position of equilibrium can exist. The stability of these oscillations is investigated.

MECHANICAL MEASUREMENTS

1722 ON MONOCHROMATIC RADIATIONS FOR A NEW DEFINITION OF THE UNIT OF LENGTH. J.Terrien.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 419-27 (1957). In Frenc

Discusses the proposed adoption of the wavelength of a suitable visible radiation as a natural unit of length. Ideal conditions for the emission of this radiation are stated and factors most likely to disturb them in practice are discussed. Interferometric investigations of light from four different discharge tubes are described and the measured line widths are shown to exceed the calculated Doppler widths. The author concludes that this additional broadeni must be understood and reduced before a natural unit of length is adopted. K.A.Thoma

1723 AUTOMATIC RECORDING DILATOMETER. C.L.Bell.
J. sci. Instrum. (GB), Vol. 38, No. 1, 27-8 (Jan., 1961).

The dilatometer described enables changes in volume with time to be followed automatically with high precision, Thus chemical reaction rates can be obtained directly without the need for graphical differentiation.

INTERFEROMETRIC MEASUREMENT OF SMALL ANGULAR DISPLACEMENTS. See Abstr. 1821

1724 SIMPLE ELECTRONIC CLOCK FOR THE STUDY OF FREELY FALLING BODIES. G.Giacomelli.
Amer. J. Phys., Vol. 28, No. 9, 817-18 (Dec., 1960).

1725 A COMPARISON OF ATOMIC BEAM FREQUENCY STANDARDS.
R.E.Beehler, R.C.Mockler and C.S.Snider.
Nature (GB), Vol. 187, 681-2 (Aug. 20, 1960).

The factors affecting the precision of frequency measurement i caesium atomic beams are discussed with specific reference to the U.S. frequency standard apparatus and its alternate. Very satisfactory agreement is shown between measurements made independently on these two machines and theory. The frequency of the $(F = 4, m_F = 0) - (F = 3, m_F = 0)$ Cs transition is 9 192 631 770.0 c/s to one part in 10^{11}. R.W.Nichol

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

1726 THE VISCOSITY OF LIQUID SULFUR. T.Matsushima.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 6, 474-8 (Dec., 1959).

The viscosity of pure sulphur and the effect of selenium, arsenic, and the organic substances on its viscosity were determined in the temperature range between 120 and 160°C. The viscosity of pure sulphur versus temperature is normally represented by the experimental formula of $\eta = Be^{A/T}$ until the ascending temperature reaches about 155°C. In the equation, which directs the linear relation between the logarithm of the viscosity and the reciprocal of the absolute temperature, the viscosity is reduced to minimum near about 155°C, and then gradually rises to the neighbourhood of 159°C. Further, a sudden increase of the viscosity is observed when temperature reaches 160°C. It is considered that t critical point of the formation of polymer sulphur exists in the temperature defined by these narrow ranges. Selenium dissolved in sulphur causes no remarkable change in viscosity, but it is considered to cause a slight depression in the above critical point wh temperature is seen to lie in the neighbourhood of 159 to 160°C of pure sulphur. The viscosity of sulphur containing arsenic has a value noticeably higher than that of pure sulphur. The change in viscosity should be demonstrated in other phases such as the equilibrium system on the variation of the molecular species of sulphur and arsenic. The results show that a minimum point is reduced t lower temperature, according to the increase in arsenic content i sulphur. The organic substances from the source of charcoal tar

hat of coal tar cause no change in viscosity. Further, distinct ifferences are not observed in various heat-treated samples below 60°C. So, the effect of the organic substances is considered to be mall in experiments.

1727 THE NON-UNIQUENESS OF POSSIBLE FORMS OF STEADY FLOW OF DENSE LIQUIDS IN THE CASE OF FROUDE NUMBERS IN THE REGION OF UNITY. N.N.Moiseev. Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 6, 860-4 (1957). In Russian.

1728 THEORY OF LOCALLY ISOTROPIC TURBULENCE OF INTERMEDIATE SCALE. S.Panchev.
. R. Acad. Bulg. Sci., Vol. 12, No. 5, 407-10 (Sept.-Oct.); No. 6, 01-4 (Nov-Dec., 1959). In Russian.

In the statistical theory of turbulence, the flow is specified in erms of mean products of two or three velocities at different points nd relations between these averages are established. In addition o some known relations of this kind, new relations are obtained by irect application of the hydrodynamical equations supplemented by dditional, hypothetical assumptions. By employing the equations etermining conduction and convection of heat in fluids, expressions re obtained for the mean products of temperatures.

R.Eisenschitz

1729 ON THE VISCOUS CORE OF A LINE VORTEX. I. N.Rott.
Z. angew. Math. Phys. (Switzerland), Vol. 9b, No. 5-6, 543-53 (1958).

1730 ON THE VISCOUS CORE OF A LINE VORTEX. II. N.Rott.
Z. angew. Math. Phys. (Switzerland), Vol. 10, No. 1, 73-81 (1959).

The temperature distribution is calculated in the viscous core of a steady line vortex, when there is a radial inflow and axial outflow superposed on the vortex motion, on the assumption of a high Reynolds number and small compressibility. A cooling effect is predicted, depending on the Prandtl number, except in the special limiting case of ideal incompressibility. J.G.Oldroyd

1731 DYNAMICS OF THE TURBULENT FREE JET. P.D.Sunavala.
J. sci. industr. Res. (India), Vol. 19 B, No. 2, 35-45 (Feb., 1960).

A general free jet equation is derived from compressible fluid flow theory which, in conjunction with data on thrust measurements, enables one to deduce the axial decay curve for any jet operating at any nozzle pressure and exit temperature in the subsonic range, according to the relation:

$$\frac{M_T}{M_o} = \frac{1}{C_m} = \frac{\Delta T_E}{\Delta T_m} = 0.22 \frac{x}{d_o} \sqrt{\frac{T_E}{T_s} \cdot \frac{W_s}{W_o}} \cdot P_c - 1.5,$$

where $P_c = \sqrt{\frac{G_{obs.}}{pA\gamma M_N^2}}$

The pressure correction factor (P_c) in the equation is found to decrease at higher subsonic pressures; this is attributed to a decrease in the thrust of nozzle efficiency. A new technique of measuring burner thrusts based on the rotating fountain principle has been devised. The P_c values derived from these thrust measurements are in quantitative agreement with the P_c values obtained from the axial decay data, thus confirming the validity of the free jet theory developed. Additional thrust measurements in the sonic region are presented which show that the P_c values increase beyond the choking conditions for a convergent nozzle.

1732 STABILITY OF A COLUMN OF ROTATING VISCOUS LIQUID. J.Gillis.
Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 152-9 (Jan., 1961).

A long column of viscous liquid of radius a and uniform density is rotating about its axis with angular velocity ω. It is shown that his motion is stable to plane perturbations of wave number s provided that the surface tension T satisfies $T \geq \rho a^3\omega^2/(s^2-1)$. This critical value is higher than that required for stability of the similar motion of a non-viscous liquid, but is otherwise independent of the coefficient of viscosity. The rate of development of instability when T is less than the critical value is also studied. Some numerical results are given. The condition was obtained by Hocking (1960) for the special cases of very high and very low Reynolds numbers.

1733 WEAK WAVES IN AN INCOMPRESSIBLE FLUID TAKING RADIATION INTO ACCOUNT. V.A.Prokof'ev.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 6, 775-82 (1957). In Russian.

Examines the influence of radiation on the propagation of waves of infinitely small amplitude. Equations are derived (on the basis of the hydrodynamic equations) for the propagation of radiation in a moving medium; this leads to a calculation of the heat flow. The effect of the internal energy on the mechanical radiation effect is considered.

1734 APPLICATION OF BOUNDARY LAYER THEORY TO EXPLAIN SOME NOZZLE AND VENTURI FLOW PECULIARITIES. G.W.Hall.
Proc. Instn Mech. Engrs (GB), Vol. 173, No. 36, 837-70 (1959).

The basis of a simple rational method for the analytical determination of discharge coefficients for the rounded-entrance nozzle and Venturi, covering the entire Reynolds number range, is presented. Certain experimental results, when compared with the theoretically derived curves, support the method. Tentative explanations are given, with the aid of the theory, for a number of puzzling and disturbing features arising from the results of some recent flowmeter calibrations. The analysis includes a new method of plotting the discharge coefficient against Reynolds number, which greatly facilitates the interpretation of experimental data.

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

1735 PHYSICAL PROPERTIES OF ISOTOPICALLY SUBSTITUTED CLASSICAL FLUIDS. W.A.Steele.
J. chem. Phys. (USA), Vol. 33, No. 6, 1619-24 (Dec., 1960).

The observed differences in physical properties between isotopically substituted classical fluids are treated in terms of the theorem of corresponding states. It is shown that these differences are at least partially due to changes in the intermolecular potential energies of interaction. When the potential function of an isotopically substituted molecule is conformal with that of the unsubstituted molecule, the differences in the physical properties of the fluids can be quantitatively related to the differences in the depth and spatial extension of the potential functions, and to the changes in the internal degrees of freedom of the molecules. It is shown that the measured properties of perdeutero benzene—benzene and perdeutero cyclohexane-cyclohexane are consistent with these equations, and that the values of the parameters chosen to fit the theory to the data are reasonable. The limits of applicability of this treatment and its possible extension to less simple systems are discussed.

1736 ADIABATIC COMPRESSIBILITY OF AQUEOUS SOLUTION OF INORGANIC ACID. Y.Ishida.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 187-96 (Sept., 1959).

The ultrasonic velocities of aqueous solutions of HCl and HNO_3 were measured and the adiabatic compressibilities were computed from them. An empirical formula is derived for the adiabatic compressibility of inorganic acids by the use of Gucker–Bachem's theory (Abstr. 4347 of 1933; 4505 of 1936).

1737 TEMPERATURE DEPENDENCE AND MAGNITUDES OF DEFORMATION CONSTANTS IN STRAINED LIQUIDS. A.Saupe.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 810-14 (Sept., 1960). In German.

The molecular statistical theory of Zocher (see Abstr. 547 of 1928) is applied to the calculation of the deformation constants. The method resembles the statistical thermodynamics of Onsager. It is found that if K is any of the three constants, $KV^{7/3}S^{-2}$ is independent of temperature, and so are the ratios of the constants. Their sum is $2.8 \times 10^8 AS^2V^{-2}(mV)^{-1/3}$ [in this respect, the author's abstract is in error]. Here V is the molar volume, S is the degree of order, and A, m are parameters characterizing the substance.

P.Gray

1738 DIFFUSION OF SOME ALLOYING ELEMENTS IN LIQUID IRON.
T.Saitô, Y.Kawai, K.Maruya and M.Maki.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 5, 401-10 (Oct., 1959).

The diffusion coefficients of silicon, sulphur and manganese in liquid iron were measured. At low concentrations, the diffusion coefficients of these elements were $2-5 \times 10^{-5}$ cm^2/sec and the activation energies for diffusion were 6–10 kcal/mole. With respect to silicon, the variation of diffusivity with the content of silicon were examined up to about 20%. The diffusion coefficient increased with the content of silicon both in pure liquid iron and in carbon-saturated liquid iron. The diffusion coefficients of silicon and sulphur decreased in the presence of carbon. These results are discussed in relation to the thermodynamic properties of the liquids.

1739 THE CRITICAL PHENOMENA BETWEEN SOLIDS AND FLUIDS. K.Furukawa.
Nature (GB), Vol. 188, 569-70 (Nov. 12, 1960).

A structural model for liquids of a quasi-face-centred cubic lattice, with 10% vacant sites, is set up for normal pressures near the melting point. Under high pressures and temperatures the vacancies are produced spontaneously. Critical values are estimated for He, N_2, CCl_4, K and Fe. It is deduced that at the surface of the earth's core, the Fe is in the liquid phase.

P.Gray

ELECTROMAGNETIC REFLECTION FROM SOUND WAVES IN LIQUIDS. See Abstr. 369

1740 VELOCITY OF ULTRASONIC WAVES IN AQUEOUS SOLUTIONS OF ZINC HALIDES. S.V.Subrahmanyam.
Nature (GB), Vol. 188, 570-1 (Nov. 12, 1960).

Ultrasonic velocity as a function of molar concentration (up to 2.5 M) was measured for three zinc halides. The velocity/concentration curve of the chloride solution passes through a maximum at 0.25 M and then decreases to a constant value. The curves of the bromide and iodide solutions decrease more rapidly throughout the range.

V.J.Hammond

1741 ULTRASONIC RELAXATION IN TRIETHYLAMINE. R.A.Padmanabhan and E.L.Heasell.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 321-8 (Sept. 1, 1960).

The absorption of ultrasonic waves in triethylamine was studied at temperatures between -50° C and 25° C, at frequencies between 10 and 100 Mc/s. These measurements supplemented those reported in 1956 by Heasell and Lamb and permitted a more detailed analysis. To explain the complete set of results it was necessary to assume the existence of a temperature-dependent entropy of activation. Physical reasons as to why this is a plausible explanation are advanced.

1742 APPLICATION OF CELL MODELS TO THE DETERMINATION OF RELAXATION TIMES IN KNESER LIQUIDS. E.Sittig.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1625-7 (Dec., 1960).

The vibrational relaxation times of several simple substances in the gaseous and liquid state are compared with values predicted by a simple cell theory of the liquid. Apart from some scatter of the experimental data, satisfactory agreement is found with the theoretical predictions.

1743 CRITICAL OPALESCENCE OF POLYSTYRENE IN CYCLOHEXANE. P.Debye, H.Coll and D.Woermann.
J. chem. Phys. (USA), Vol. 33, No. 6, 1746-51 (Dec., 1960).

Light scattering measurements on the system cyclohexane–polystyrene (molecular weight range 69 000 to 1 000 000) show an angular dissymmetry of critical opalescence in essential agreement with theory. The interaction range between polymer segments as calculated from the data appeared to be considerably smaller than the radius of gyration of the polymer coil. The dependence of critical temperature and concentration on the molecular weight is shown.

1744 OBSERVATIONS OF THE EMISSION OF LIGHT ON DISSOLUTION OF IRRADIATED SOLIDS IN CERTAIN LIQUIDS. T.Westermark and B.Grapengiesser.
Nature (GB), Vol. 188, 395-6 (Oct. 29, 1960).

Dry NaCl, LiF, KI, glucose, saccharose, alginic acid and polystyrene were irradiated by γ- or 2 MeV β-rays to a dose of 200 Mrads. On dissolution in an aqueous or non-aqueous solvent containing solutes, known to be fluorescent to u.v. or X-radiation, light emission is observed. This was measured by photomultiplier The surface activity of the solute influences the light intensity, which is bright enough to be observed visually. Polystyrene gave qualitatively similar light pulses whether irradiated or treated by electrical a.c. corona discharges. Thallium chloride in water enhances light emission of irradiated NaCl dissolving in water, whereas gadolinium, neodymium, samarium, terbium and europium ions had no such effect. Comparing the light emission of irradiated NaCl with that of tritiated water in the same solute system, a rough estimate of energy release is made suggesting that about 3% of the radiation energy received by the NaCl had been stored. The relevance of these observations to problems of food preservation by radiation is discussed.

M.Ebe

1745 THE ENERGY TRANSFER IN LUMINESCENT SOLUTIONS. II. SOLUTIONS WITH TWO LUMINESCENT SOLUTES. H.K.Bothe.
Ann. Phys. (Germany), Vol. 6, No. 3-4, 156-68 (1960). In German.

The investigations described in Pt I (Abstr. 6806 of 1960) are extended to solutions containing two different luminescent solutes. Functions for dependence of luminescence on the concentration of solutes are determined. Experimental verification of the relations are found using polystyrene as solvent and indications of the nature of the transfer mechanism are given which favour a process of inter molecular collisions.

G.F.J.Garlick

1746 ORGANIC LIQUID SCINTILLATORS. M.Wilk.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 806-10 (Sept., 1960). In German.

The scintillation yield under Sr^{90} of 1% solutions in toluene of several aromatic hydrocarbons and a few related compounds is compared with that of p-terphenyl. Hindrance to free rotation in the molecule reduces the yield, especially in rubrene. The reasons are discussed for the increased yield in tetrabromorubrene and in some heterocyclics closely related to the hydrocarbons. The small yield shown by some water-soluble organic compounds can be increased by addition of proteins to the solutions.

S.T.Henders

1747 RELAXATION TIMES OF SOME DISUBSTITUTED BENZENES. A.Vyas.
J. sci. industr. Res. (India), Vol. 19 B, No. 2, 49-51 (Feb., 1960).

Relaxation times of o-, m- and p-nitrotoluenes, o- and m-nitroanilines and o-toluidine were determined in dilute solutions in benzene at 3.15 cm wavelength. For nitrotoluenes, the relaxation time was found to increase from o- to m- and from m- to p- in the same order as the dipole moment. For nitroanilines, the relaxation time also increases in a similar manner from o- to m-. The relaxation times decrease in the following order in the three compounds: o-toluidine < o-nitrotoluene < o-nitroaniline.

1748 DIELECTRIC DISPERSION OF POLAR LIQUIDS. I. ETHYL BENZOATE, AMYL BENZOATE AND ETHYL CINNAMATE. B.Lakshminarayana.
J. sci. industr. Res. (India), Vol. 19 B, No. 3, 87-91 (March, 1960).

The dielectric dispersion of three esters was studied: ethyl benzoate, amyl benzoate and ethyl cinnamate. The dielectric constant and dielectric loss factor at 1000 and 2000 Mc/s were determined employing a coaxial line set-up, and at 9200 Mc/s using the waveguide method suggested by Poley (Abstr. 7939 of 1955). The static dielectric constant was measured in the conventional manner. The results obtained for ethyl benzoate and amyl benzoate conform to the Cole–Cole type of semicircular representation of dielectric data with a single relaxation time, while for ethyl cinnamate a distribution of relaxation times has to be postulated. The possibility of a second dispersion in the millimetre region is discussed.

1749 DIELECTRIC DISPERSION OF POLAR LIQUIDS. II. ETHYL LACTATE AND ISOAMYL LACTATE. B.Lakshminarayana.
J. sci. industr. Res. (India), Vol. 19B, No. 6, 187-90 (June, 1960).

The dielectric properties of ethyl lactate and isoamyl lactate were studied at five different frequencies. The results are discussed in terms of the Cole–Cole, Fuoss–Kirkwood and Macdonald relations for the distribution of relaxation times. A comparison of the two distribution functions is made. The possibility of a second dispersion in the millimetre region is indicated.

1750 DIELECTRIC DISPERSION OF POLAR LIQUIDS. III. ASYMMETRIC DISPERSION IN GLYCEROL.
.Lakshminarayana.
. sci. industr. Res. (India), Vol. 19B, No. 9, 329-33 (Sept., 1960).

The dielectric dispersion was studied at 28° C in the microwave and u.h.f. regions. The behaviour of glycerol could be well epresented by an equation proposed by Davidson and Cole (Abstr. 817 of 1951; 1763 of 1952):

$$\epsilon^* = \epsilon_\infty + (\epsilon_s - \epsilon_\infty)/(1 + j\omega\tau')^b,$$

where b = 0.592 and $\tau' = 10.04 \times 10^{-10}$ sec. A correlation is ttempted between Davidson and Cole's measurements and the resent measurements by a study of the variation of τ' with tempera- ure. The results show that the skewed arc locus is a fair repre- entation of the data over a wide range of temperatures (from 28° to −70° C). The temperature dependence of relaxation time ndicates that low temperatures may not play an important role in he asymmetric frequency dependence of dispersion.

1751 STUDY OF THE DIELECTRIC BEHAVIOUR OF LIQUID MIXTURES. I. n-OCTYL ALCOHOL-DIETHYLENE LYCOL AND n-PROPYL ALCOHOL-GLYCEROL MIXTURES.
.Sarojini.
. sci. industr. Res. (India), Vol. 19 B, No. 2, 52-4 (Feb., 1960).

The dielectric behaviour of two liquid mixtures, n-octyl lcohol–diethylene glycol and n-propyl alcohol–glycerol, was in- estigated in the u.h.f. region using the standing wave method of oberts and Von Hippel [Abstr. 939B of 1947; J. appl. Phys. (USA), ol. 17, 1610 (1946)].Schallamach's (1946) suggestion that the pro- ess of dielectric relaxation in liquid mixtures is a disturbance over n appreciable region in the liquid does not appear to be valid for ese mixtures.

1752 STUDY OF DIELECTRIC BEHAVIOUR OF LIQUID MIXTURES. II. ETHYL ALCOHOL–α–BROMO-APHTHALENE AND ETHYL ALCOHOL–O–CRESOL. V.Sarojini.
. sci. industr. Res. (India), Vol. 19 B, No. 3, 91-3 (March, 1960).

The dielectric behaviour of two liquid mixtures, ethyl and lcohol–α–bromonaphthalene and ethyl alcohol–o–cresol, the latter ontaining both associated liquids, was investigated in the frequency ange 900-2000 Mc/s. The results confirm the conclusion arrived at the earlier studies: Schallamach's suggestion does not appear to e valid for these.

1753 DIELECTRIC STUDY OF SOME LIQUID ALKYL NITRITES. R.F.Grant, D.W.Davidson and P.Gray.
. chem. Phys. (USA), Vol. 33, No. 6, 1713-18 (Dec., 1960).

The dielectric constants of liquid methyl, n-propyl and iso- ropyl nitrite were measured over an extensitve range of tempe- ature and the results used to estimate the relative abundances of he trans and cis isomers. It is concluded that the trans form pre- ominates in all three liquids, in contradiction, in the case of the ropyl nitrites, to the conclusions from recent n.m.r. studies. It s suggested that the assignments to the appropriate n.m.r. peaks hould be reversed for the higher alkyl nitrites. Dielectric relaxa- ion in n-propyl nitrite was found to be of the asymmetrical Cole–Davidson type.

1754 THE THEORY OF THE PRESSURE IN POLAR DIELECTRICS IN INHOMOGENEOUS ELECTRIC FIELDS.
.H.Krawinkel.
. angew. Phys. (Germany), Vol. 12, No. 11, 525-7 (Nov., 1960).
n German.

In a previous paper (Abstr. 3724 of 1960), the author assumed he Lorentz expression for the internal field. The formulae for the olarization and the pressure in a polar liquid in an inhomogeneous eld are now recalculated using a more general expression for the nternal field. K.W.Plessner

STRUCTURE AND RELAXATION OF DIELECTRIC LIQUIDS. EVIEW. See Abstr. 1125

1755 THE INFLUENCE ON THE OIL DIELECTRIC STRENGTH OF THE GAS PRESSURE IN EQUILIBRIUM ITH THE OIL. P.Gazzana-Priaroggia and G.Palandri.
. Electrochem. Soc. (USA), Vol. 107, No. 11, 884-6 (Nov., 1960).

An investigation of the influence of gas pressure on the electrical reakdown of thin oil, as used in oil-filled cables, was carried out at as pressures between about 5×10^{-6} and 1000 mm Hg. The test cell onsisted of a glass container enclosing a platinum sphere gap).5 mm). Tests were carried out at ambient temperature. The results of this investigation showed that the dielectric strength of the oil is absolutely independent of the gas pressure, provided a perfect equilibrium is reached between the gas dissolved in the oil and the free gas remaining in the cell above the oil surface.

1756 T_2 MEASUREMENTS USING THE SPIN-ECHO TECHNIQUE. I.Solomon.
J. Phys. Radium (France), Vol. 20, No. 8-9, 768 (Aug.-Sept., 1959).
In French.

The transverse relaxation time T_2 was measured in water at a frequency of 28 Mc/s at 24° C. Values obtained, independent of pH, are:-for non-degassed water $T_1 = 2.6 \pm 0.1$ sec and $T_2 = 2.2 \pm 0.1$ sec; for deoxygenated water $T_1 = 3.3 \pm 0.1$ sec, and $T_2 = 2.65 \pm \pm 0.1$ sec. These results do not agree with those of Meiboom et al. (Abstr. 6384 of 1958). It is suggested that the variation of T_2 is due to a reaction with the surfaces to which the gas is exposed.
S.A.Ahern

1757 FINE STRUCTURE OF PROTON RESONANCE SPECTRA OF FLUOROBENZENE DERIVATIVES.
M.Kimura, S.Matsuoka, S.Hattori and K.Senda.
J. Phys. Soc. Japan, Vol. 14, No. 5, 684 (May, 1959).

The proton resonance spectra of p-bromo-fluorobenzene and p-iodo-fluorobenzene were studied at high resolution. The spectra showed fine structures due to spin–spin coupling; they were analysed as the type A_2B_2 with C_{2V} symmetry. S.A.Ahern

1758 NUCLEAR MAGNETIC RESONANCE OF Xe^{129} IN NATURAL XENON. R.L.Streever and H.Y.Carr.
Phys. Rev. (USA), Vol. 121, No. 1, 20-5 (Jan. 1, 1961).

The spin–lattice relaxation time T_1 of Xe^{129} was measured as a function of temperature in the liquid and as a function of pressure in the gas. A strong shift ΔH in the external field required for resonance at constant frequency but varying sample density ρ was discovered. As the sample density increases in the region above 48 atm, ΔH decreases linearly at the rate of 3.45 mG per amagat (density at standard conditions) in a field of 8060 G. In the liquid the temperature dependence of the product of T_1 and ρ can be described by an activation energy of 0.7 ± 0.1 kcal mole. In the gas at room temperature between 48 and 73 atm, T_1 varies as $\rho^{-2.1 \pm 0.4}$. The largest value of T_1 observed was 2600 ± 600 sec for a gas sample at 48 atm, and the shortest value was 57 ± 2 sec in the liquid at −101° C. The experimental values of T_1 were compared with theoretical predictions in two limiting cases, the rare gas and the dense liquid. In both cases the experimental values, although larger than previously reported values, are still two to three orders of magnitude smaller than predicted from an intermolecular nuclear magnetic dipole interaction. The relaxation time was found to be independent of field. Implications of these data for determining the relaxation mechanism are discussed. It is suggested that the relaxation may be caused by a fluctuating magnetic field at the nucleus resulting from the motion of nonsymmetrical electronic charge distributions during collisions.

MECHANICS OF GASES

1759 VISCOSITY OF STEAM AT SUPERCRITICAL PRESSURES. J.H.Whitelaw.
J. mech.Engng Sci. (GB), Vol. 2, No. 4, 288-97 (Dec., 1960).

The kinematic viscosity of steam was measured at pressures from 200 to 800 kg/cm² and at temperatures from 370° to 650° C. The Rankine-type viscometer used for these determinations was originally designed by Kjelland-Fosterud [J. mech. Engng Sci. (GB), Vol. 1, No. 1, 30-8 (June, 1959)] who obtained preliminary results from it. To improve the reliability and precision of results, several modifications to the original apparatus have been effected and these are described in the text. The standard deviation of the measured values is ±1.5% and, in general, these are lower than the accepted values given by Timrot (1940). Further, the results indicate a smaller dependence on pressure than hitherto accepted.

1760 STUDY OF THE LIMIT OF VARIATION OF THE VISCOSITY OF OXYGEN WITH MAGNETIC FIELD.
V.Mercea and I.Ursu.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 277-88 (1958).
In Roumanian.

The paramagnetic effects of oxygen were studied. A new, more

sensitive method for the measurement of feeble variations in the viscosity of gases was devised. This was used to determine the magnetic variation of the viscosity of oxygen and air from the flow through seven capillary tubes of different radii; this allowed the dependence of the effect studied on the radius of the capillaries to be established. It is also shown that the magnetic variation of the viscosity of oxygen and of air can serve as the basis for critical discussions on the different laws of flow and of the validity of the hypotheses on which they depend. The most plausible seems to be a hypothesis based on the anisotropy of molecular collisions.

S.Weintroub

1761 MULTIPLE TUBE COLLIMATOR FOR GAS BEAMS. G.R.Hanes.

J. appl. Phys (USA), Vol. 31, No. 12, 2171-5 (Dec., 1960).

A multiple-tube gas collimator is described which consists of a bundle of tubes with 20-μ radii, made by electrolytic removal of copper wires from the plastic matrix in which they were embedded. Details of construction are given, as well as measurements of the angular distribution of gas flow from the collimator, which are determined with a helium mass spectrometer leak detector. The theory of flow through multiple tube sources is discussed, and the figure of merit giving relative values of beam intensity for fixed collimator area and flow rate is derived. The collimator described in this paper compares favourably with those used by previous workers.

1762 THE STRUCTURE OF MACH'S LINES IN MATTER SUBJECT TO RELAXATION.

I.P.Stakhanov and E.V.Stupochenko.

Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1044-7 (Oct. 11, 1960). In Russian.

Two-dimensional supersonic flow of a fluid past a thin wedge is analysed in terms of the authors' "relaxational hydrodynamics" (see Abstr. 110 of 1961). It is found that local perturbations propagate along thin strips rather than along lines of infinitesimal breadth such as they would according to ordinary hydrodynamics. [English translation in Soviet Physics–Doklady (USA)].

R.Eisenschitz

1763 THEORY OF THE BORDA NOZZLE FOR GASES. Ya.I.Sekerzh-Zen'kovich.

Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 6, 850-5 (1957). In Russian.

Simplified formulae are found for the calculation of the jet contraction. This leads to a method for determining the form of the free jet after separation. The results are tabulated.

Shock Waves

1764 THE STRONG DISCONTINUITY [AT A SHOCK FRONT] IN A NON-IDEAL GAS. S.I.Anisimov.

Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1124-7 (Sept., 1960). In Russian.

By solving the equations of motion, the pressure, density and velocity are obtained as functions of the distance from the shock front. Results are shown in a graph applying to underwater shock waves.

R.Eisenschitz

1765 ON COMPLETE BLAST SCALING. U.Ericsson and K.Edin.

Phys. of Fluids (USA), Vol. 3, No. 6, 893-5 (Nov.-Dec., 1960).

Experimental evidence is presented for the ability of Sachs' complete energy scaling to account for the influence of ambient pressure and temperature at not too small distances from the charge.

STRONG POINT-EXPLOSION IN A COMPRESSIBLE MEDIUM. See Abstr. 1474

GASEOUS STATE

1766 THE VIRIAL COEFFICIENTS OF HELIUM FROM 20 TO 300° K.

D.White, T.Rubin, P.Camky and H.L.Johnston.

J. phys. Chem. (USA), Vol. 64, No. 11, 1607-12 (Nov., 1960).

The compressibility of gaseous helium from the boiling point of liquid hydrogen to 300° K in the pressure range from 1 to 33 atm was determined. The 22 experimental PV isotherms are represented by an equation of state containing three virial coefficients. The second virial coefficients are compared with those calculated from various intermolecular potential functions for helium suggested in the literature. The agreement is fair.

1767 THERMAL FORCE ON PARTICULATE MATERIAL AT HIGH KNUDSEN NUMBERS IN THE ABSENCE OF A THERMAL GRADIENT. W.H.Hughes.

J. Colloid Sci. (USA), Vol. 15, No. 4, 307-12 (Aug., 1960).

A mechanism for a force arising from thermal effects is considered for small particles surrounded by gas under conditions of high Knudsen number in the absence of a thermal gradient. A simplified model is assumed. The force is found to be proportional to the pressure and the cross-sectional area of the particle. The resulting velocity is found to be independent of these parameters.

1768 A METHOD FOR ADIABATIC COMPRESSION OF GASES UNDER CONTROLLED CONDITIONS.

G.D.Graham and O.Maass.

Canad. J. Chem., Vol. 38, No. 12, 2482-7 (Dec., 1960).

An experimental technique is described by means of which the specific heats of gases may be measured at high temperatures and pressures. With the transducer employed, consistent results were obtained up to 7000 lb/in^2 and it is proposed to incorporate a transducer having a much higher pressure range where it is estimated that temperatures up to 10 000° K can be recorded.

1769 NATURE OF FLUIDS IN THE HYPERCRITICAL REGION. J.F.Counsell and D.H.Everett.

Nature (GB), Vol. 188, 576-7 (Nov. 12, 1960).

Above the critical point, fluids exhibit relatively rapid changes in thermodynamic properties, as if there were a smoothed phase transition in the system. One can attempt to define a "transition locus": two suggested definitions are $(\partial C_p/\partial p)_T = 0$ and $(\partial C_p/\partial T)_p = 0$. It is here pointed out that, in fact, no satisfactory single definition can be made and that it seems best to regard the transition as occurring over a region bounded by the two loci defined above. Nine references to earlier discussions are given.

R.O.Davies

EFFECT OF TARGET GAS TEMPERATURE ON THE SCATTERING CROSS-SECTION. See Abstr. 471

1770 COMBINING OF THE RARE GAS CONTINUA. Y.Tanaka and A.S.Jursa.

J. Opt. Soc. Amer., Vol. 50, No. 11, 1118-19 (Nov., 1960).

An attempt was made to combine the vacuum ultraviolet continua of the rare gases by means of a discharge in a mixture of two of these gases. Argon/xenon mixtures emitted the xenon spectrum only; argon/krypton mixtures produced the krypton continuum only. A successful combination of the spectra was obtained by placing two individual discharge tubes one behind the other. A spectrogram shows the smooth combination of the argon and krypton continuum, extending from 1100 to 1650 A. The method presents a problem because of the unbalanced intensity with which the radiation from each source arrives at the entrance slit of the spectrograph.

F.R.Walters

OPTICAL RESONANCE AND SELECTIVE REFLECTION WITH CADMIUM AND ZINC VAPOURS. See Abstr. 802

1771 INTERMOLECULAR TRANSFER OF EXCITED ELECTRON ENERGY. T.Förster.

Z. Elektrochem. (Germany), Vol. 64, No. 1, 157-65 (1960). In German.

Studies of sensitized fluorescence in gases are discussed, quantitatively for dipole–dipole interactions and qualitatively for higher-order interactions. Such processes are assumed to be applicable to impurity sensitization in molecular crystals. Results from various workers are assessed in relation to possible models for energy transfer.

G.F.J.Garlick

BIBLIOGRAPHY ON GASEOUS DIELECTRIC PHENOMENA. See Abstr. 1895

APPLICATION OF CELL MODELS TO THE DETERMINATION OF RELAXATION TIMES IN KNESER LIQUIDS. See Abstr. 1742

1772 NUCLEAR POLARIZATION IN He^3 GAS INDUCED BY OPTICAL PUMPING AND DIPOLAR EXCHANGE.
.A.Bouchiat, T.R.Carver and C.M.Varnum.
ys. Rev. Letters (USA), Vol. 5, No. 8, 373-5 (Oct. 15, 1960).
Nuclear polarization of He^3 gas was produced by optical pumng on natural Rb vapour with attendant transfer of the polarizaon to He^3 by the Overhauser effect. Pressures used were 2.8 atm r He^3, and 10^{-3} mm Hg for Rb. Ideally, polarization of He^3 should oceed with a characteristic time comparable to the He^3 relaxation ne at that pressure. However, the relaxation time was found to be nsiderably shortened by wall relaxation. Nevertheless, enhanceent of the nuclear polarization by a factor of 10^4 above the initial ltzmann distribution of 10^{-8} was observed. Optical pumping was complished with the Rb D_1 line and the nuclear polarization was served with n.m.r. techniques. It should be possible to perform e experiment with any noble gas having a nuclear moment.
P.M.Parker

Xe^{129} NUCLEAR MAGNETIC RESONANCE IN GASEOUS ENON. See Abstr. 1758

VACUUM PHYSICS

1773 INVESTIGATION OF A DEMOUNTABLE ION PUMP WITH CATHODIC SPUTTERING.
.Komsha and K.Simionesku.
ev. de Physique (Roumania), Vol. 5, No. 2, 199-209 (1960).
n Russian.
Briefly reviews the literature of high-speed ion-getter pumps nd outlines their advantages over oil or mercury diffusion pumps. ttention is then concentrated on the ion-getter pump of moderate peed (10 litres/sec) of the type previously described by Hall Abstr. 3782 of 1958). An improved, demountable version has been eveloped by the authors. The pump body is of stainless steel with opper or aluminium gaskets to permit high temperature baking. ossible fields of application of the new pump are indicated.
A.E.I. Research Laboratory

1774 AN EVAPORATION APPARATUS FOR RADIOACTIVE SUBSTANCES. W.Bühring and J.Heintze.
uclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 286-7 eb., 1960). In German.
A vacuum evaporation device has been constructed using elecon bombardment heating. The crucible containing the material be evaporated has a well directed emission characteristic and an be easily exchanged. The device,therefore, is well suited for e evaporation of radioactive materials.

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

1775 OUTLINE OF THE HISTORY OF FLEXIBLE OR ELASTIC BODIES TO 1788. C.Truesdell.
Acoust. Soc. Amer., Vol. 32, No. 12, 1647-56 (Dec., 1960).
A new history to 1788, drawn from detailed study to be pubshed of all the available sources, is [C. Truesdell, The Rational echanics of Flexible or Elastic Bodies, 1638-1788, Leonhardi uleri Opera Omnia (Ser. II, Vol. 11, Part 2, to appear in 1960)]. he present article provides a list of some of the specific, disveries described therein.

1776 FREQUENCY RESPONSE OF A NONLINEAR STRETCHED STRING. D.W.Oplinger.
Acoust. Soc. Amer., Vol. 32, No. 12, 1529-38 (Dec., 1960).
The problem of the forced vibration of an elastic string with riable tension is considered. An equation of motion is given for e case of low-amplitude motion, but for strings of high modulus r which it is shown that tension variations are an important source nonlinearity. An exact solution is obtained by assuming as a iving function a Jacobean elliptic function of the cosine type. ension variations and amplitude are calculated as functions of equency. Experimental results are presented and compared with e theory.

1777 DYNAMICS OF A HOLLOW, ELASTIC CYLINDER CONTAINED BY AN INFINITELY LONG RIGID CIRCULAR-CYLINDRICAL TANK.
J.H.Baltrukonis, W.G.Gottenberg and R.N.Schreiner.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1539-46 (Dec., 1960).
Dispersion equations are derived for the propagation of transverse waves within an infinitely long thick-walled hollow elastic cylinder which is perfectly bonded along its outer cylindrical surface to an infinitely long rigid circular-cylindrical tank. In the case of infinite wavelength the dispersion equations reduce to two uncoupled frequency equations; one defining the natural frequencies of free vibrations of the hollow elastic core in the antisymmetric axial shear mode and the other defining the natural frequencies of plane strain vibrations. Some numerical results are presented for the dispersion equations and the two frequency equations and references are given to more detailed results.

1778 EFFECTS OF DYNAMICAL NONLINEARITY ON EXTREMAL STATISTICS. D.A.Smith and R.F.Lambert.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1700-1 (Dec., 1960).
Experimental studies of the probability distribution of strain extrema resulting from nonlinear random vibrations of an elastic bar are here reported. The distribution of extrema are found to deviate from a Rayleigh distribution which holds experimentally for linear motion. Of particular interest are large strain levels where the distribution of maxima fall above a Rayleigh distribution while the minima lie below.

1779 MOTION OF A RIGID CYLINDER DUE TO A PLANE ELASTIC WAVE. J.W.Miles.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1656-9 (Dec., 1960).
The motion of a rigid cylinder resulting from a normally incident, monochromatic, plane, elastic wave of either P (longitudinal) or S (transverse) type is calculated. Numerical results are presented in the form of curves.

1780 WAVE PROPAGATION IN RUBBER.
N.Kristesku.
Priklad. Mat. i Mekh. (USSR), Vol. 21, No. 6, 795-800 (1957). In Russian.
Considers a rubber beam, which is deformed in a certain way by a static load and to which is applied a monotonously increasing, dynamic load. The resulting wave phenomena are investigated for different initial stresses. Reflection effects are neglected by considering a sufficiently long beam. Stress–strain curves are given. The occurrence of shock waves is investigated.

1781 THE REFLECTION OF RAYLEIGH WAVES BY A HIGH IMPEDANCE OBSTACLE ON A HALF-SPACE.
R.W.Fredricks and L.Knopoff.
Geophysics (USA), Vol. 25, No. 6, 1195-1202 (Dec., 1960).
The reflection of a time-harmonic Rayleigh wave by a high impedance obstacle in shearless contact with an elastic half-space of lower impedance is examined theoretically. The potentials are found by a function–theoretic solution to dual integral equations. From these potentials, a "reflection coefficient" is defined for the surface vertical displacement in the Rayleigh wave. Results show that the reflected wave is $\pi/2$ radians out of phase with the incident wave for arbitrary Poisson's ratio. The modulus of the "reflection coefficient" depends upon Poisson's ratio, and is evaluated as $r_R = 0.265$ for $\sigma = 0.25$.

1782 TRANSMISSION AND REFLECTION OF RAYLEIGH WAVES BY WEDGES. L.Knopoff and A.F.Gangi.
Geophysics (USA), Vol. 25, No. 6, 1203-14 (Dec., 1960).
Experimental observations were made of the transmission and reflection of Rayleigh waves by wedges. Results are reported for Rayleigh waves in aluminium wedges. It is observed that the wave shapes of the transmitted and reflected waves differ from that of the incident wave and depend on the angle of the wedge. The change of shape is attributed to an interference between part of the incident wave-form and the radiation from a line source placed at the vertex. A procedure is given for the calculation of the partition between the two terms.

ACOUSTICS

1783 ENERGY-MOMENTUM TENSOR FOR PLANE WAVES. P.A.Sturrock.
Phys. Rev. (USA), Vol. 121, No. 1, 18-19 (Jan. 1, 1961).

A general form is established for the energy momentum tensor for plane waves propagating in a homogeneous medium, the field equations of which are derivable from a quadratic Lagrangian function. Energy density and momentum density are proportional to frequency and the wave vector, the coefficient of proportionality being "action density". Energy flow and momentum flow are related to energy density and momentum density by the group velocity. The relation between momentum density and the wave vector is valid even in a nonlinear system. For a wave packet, one finds that the total energy is related to frequency and the total momentum to the wave vector by the total action of the packet, in close analogy with corresponding relations of quantum mechanics.

1784 THEORY OF SOUND PROPAGATION THROUGH DUCTS CARRYING HIGH-SPEED FLOWS. A.Powell.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1640-6 (Dec., 1960).

The important problem of sound propagation in ducts carrying compressible subsonic flows is analysed on the basis that the motion is one-dimensional. The multiple reflection method is extended to the case of sinusoidally varying pressure waves and a general integral formulation is developed. It is complicated because the total reflected wave, particularly, and the total transmitted wave must depend upon the time delay incurred by the propagation of infinitesimal reflections from along the length of the duct, and this depends upon the shape of the duct. It is shown how certain exact solutions can be obtained and these are given for the wave strengths composed of wavelets having undergone single, double and triple reflections. The frequency plays the strongest role in the reflected wave, and when the singly reflected wavelets dominate, it introduces a factor

$$[\sin(\Omega\chi)/\Omega\chi]e^{-i\Omega\chi}$$

on the zero-frequency reflection, Ω being proportional to the frequency, and it and χ being dependent upon the change of Mach number at the ends of the duct. In contrast the transmitted wave is hardly affected by frequency. The analytical results apply to "almost conical" ducts, either convergent or divergent with the incident wave propagating with or against the flow direction. An approximate method, based upon the analytical results is demonstrated for ducts of other form.

1785 TRANSIENT SOUND PROPAGATION IN A LAYERED LIQUID MEDIUM. J.W.C.Sherwood.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1673-84 (Dec., 1960).

A theoretical analysis is made of transient sound propagation between a source and receiver located at arbitrary points in a horizontally stratified liquid medium. Definite integral expressions are developed for an event which has been reflected from, and transmitted through, the interfaces in some designated manner. This event always contains a disturbance which has an onset corresponding to the arrival time predicted by simple acoustic wave theory; for a large horizontal offset of the receiver this arrival may be preceded by by a refracted disturbance. The total pressure variation at the receiver, up to some time t, may be ascertained by evaluating all the reflected and refracted events that have onsets preceding t. The employment of a high-capacity digital computer should permit a detailed investigation of problems which involve a few strata only and a receiver offset which is not excessive. It is emphasized, however, that such investigations would involve considerable computing costs, and it is, therefore, economically desirable to incorporate certain approximations into the theoretical analysis.

1786 METHOD FOR MEASURING ATTENUATION OF ULTRASONIC LONGITUDINAL WAVES IN PLASTICS AND ROCKS. M.Auberger and J.S.Rinehart.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1698-9 (Dec., 1960).

An extension of Hughes pulse technique is described for measurements in plastics and rocks. Data are given for Plexiglas and granite in the frequency range: 250-1000 kc/s.

1787 THE EFFECT OF ATTENUATION ON THE ACOUSTIC RESONANT FREQUENCIES OF GASES IN TUBES. H.J.Wintle.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 772-5 (Nov., 1960).

The change in the resonant frequencies of a sound tube due to dependence of attenuation on frequency is worked out for two cases practical interest. The effect on measured values of the velocity sound is shown to be significant in accurate work.

1788 IMPROVEMENTS IN THE SING-AROUND TECHNIQUE FOR ULTRASONIC VELOCITY MEASUREMENTS. R.L.Forgacs.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1697-8 (Dec., 1960).

A system was developed for measurements in solids. In the developed system, a selected cycle of a selected echo is gated out, to retrigger the transmitter. Highly stable circuitry is employed. The timing system incorporates two modified commerical electron counters and associated circuitry to maximize stability and detect sensitivity. Environmentally induced sample velocity changes of t order of one part in 10^7 maybe detected, provided that the accompa ing attenuation change is negligible, or that steps taken to compensate for ultrasonic attenuation changes to adjusting electronic attenu ation, produce phase shifts which are known to sufficient accuracy

1789 NOTE ON "SOURCES OF SOUND IN PIEZOELECTRIC CRYSTALS". H.E.Van Valkenburg.
J. Acoust. Soc. Amer., Vol. 32, No. 11, 1468 (Nov., 1960).
See Abstr. 14733 of 1960.

1790 UNDERWATER EXPLOSIONS AS ACOUSTIC SOURCES D.E.Weston.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 233-49 (Aug., 1960).

The manner in which underwater explosions differ from low-amplitude point sources of sound is considered theoretically, especially effects due to cavitation near the sea surface. Some measured differences between the acoustic source levels of variou size charges and some absolute charge source levels are given. These experimental results are presented for charge sizes betwee 0.002 and 50 lb, for charge depths from 7 to 60 fathoms, and for frequencies from 25 c/s to 6.4 kc/s. The results at a given depth are shown to obey a simple scaling law. Theoretical source levels are calculated by Fourier analysis of shot pressure–time curves reported by Arons (1948, 1954). At high frequencies the theoretica spectral energies of the shock wave and the bubble pulses are sim added together, but at low frequencies it is necessary to take acco of phase. In general, there is very good agreement between the ex perimental and theoretical levels, and certain small discrepancies are explained in terms of bubble migration and related effects.

1791 DETERMINATION OF SOUND ABSORPTION COEFFICIENTS USING A PULSE TECHNIQUE. C.L.Rogers and R.B.Watson.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1555-8 (Dec., 1960).

A pulse method using a sound mirror to produce directed sou pulses allows determination of the coefficients by essentially a fre field method but within the confines of an ordinary laboratory. Average pulse pressures for brief pulses are obtained over both space and time to allow evaluation of the absorption coefficient as a function of angle of incidence. When averaged over angle of incidence, this function leads to an average absorption coefficient. Average coefficients were obtained for samples of two different materials. These coefficients, for a pulse two cycles long at 200 c are 0.56 and 0.182. Comparable values computed from impedance tube data are 0.57 and 0.186; and values obtained from reverberat chamber measurements are 0.57 and 0.130. In each case the three values for each material lie within the estimates of error assigne It is concluded that while the pulse method is confined to short pulses having relatively wide frequency spectra, the method is useful both in producing values of sound absorption coefficients as a function of angle of incidence and of average values of these coefficients.

1792 THE EFFECT OF ABSORBENT WALLS OF A CLOSE SPACE ON THE UNIFORMITY OF THE SOUND FIEL E.Bădărău, Gh.Guirgea and M.Grumăzescu.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 3, 435-41 (1959). Roumanian.

From the results, worked out with the aid of parallelepiped models, the effectiveness of various solutions was determined.

1793 INTERPRETATION OF ULTRASONIC ECHO AMPLITUDE. J.C.V.Rumsey.
rit. J. appl. Phys., Vol. 12, No. 1, 25-9 (Jan., 1961).

The equation

$$S = S_0 \int_0^{kaT/R} \frac{\{J_1(x)\}^2}{x} dx$$

deduced for the amplitude S of the signal received by a transucer, radius a, from a circular discontinuity, radius T, which is lane and parallel to the transducer face at a distance R, where = $2\pi/\lambda$ and $x = kat/R$, S_0 being an arbitrary reference amplitude. xperiments verifying the equation are described, and the results uoted. The equation is shown to be more generally applicable than ne recently put forward by Krautkrämer (Abstr. 5109 of 1960). It shown that the equation obviates the use of the many test-blocks at resent used in ultrasonic inspection.

1794 FLUCTUATIONS OF SOUND REFLECTED FROM THE SEA SURFACE. C.S.Clay.
. Acoust. Soc. Amer., Vol. 32, No. 12, 1547-51 (Dec., 1960).

Experimental data on the reflection of sound from the sea urface suggest that the fluctuations of the received signals are due o the scattering of sound from the irregular sea surface. These ata are compared with calculations based on the theory of Eckart Abstr. 5348 of 1953). A Gaussian correlation function for the sea urface was assumed for the calculations. The scattered sound epends upon the sea surface parameters, source position, receiver osition, and acoustic wavelength. The numerical calculations of cattered sound had the same dependence on the source-receiver eparation as the experimental data. By using this, the correlation istance and r.m.s. wave height are estimated for the sea surface.

1795 FLUCTUATIONS IN SURFACE-REFLECTED PULSED C.W. ARRIVALS. M.V.Brown and J.Ricard.
. Acoust. Soc. Amer., Vol. 32, No. 12, 1551-4 (Dec., 1960).

A pulse of 168 c/s sound was scattered from the ocean surface nd analysed for fluctuation as a function of the angle of incidence. $\propto (\cos\varphi)^{2.5}$ relation is found between the relative standard deviation f the energy and the incident angle, as measured from the normal.

1796 THE CONCEPT OF ACOUSTIC IMPEDANCE. A.Hilf.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 3, 443-8 (1959). In Roumanian.

A general formula is proposed for the acoustic impedance of slits, in conditions of laminar flow. The calculations were carried ut on the basis of energy considerations. A general expression is btained which is valid for all forms of slit.

1797 INTERFERENCE PATTERNS IN THE NEAR FIELD OF A CIRCULAR PISTON. J.T.Dehn.
. Acoust. Soc. Amer., Vol. 32, No. 12, 1692-6 (Dec., 1960).

A number of ultrasonic ring patterns, recorded photographiclly in the near field of a circular piston, are presented. In appearnce they resemble the diffraction patterns of light in front of a ircular aperture which appear in most textbooks on physical optics. irst, the method of recording is commented upon. Then the positions of the central maxima and minima are shown to agree with the redictions of wave theory. Finally, a simple ray theory, based on a ethod first proposed by Schoch and capable of giving a qualitative icture of the field in front of the piston, is discussed.

1798 ON THE DIFFRACTION OF MULTIPOLE FIELDS BY A SEMI-INFINITE RIGID WEDGE.
I.Yildiz and O.K.Mawardi.
. Acoust. Soc. Amer., Vol. 32, No. 12, 1685-91 (Dec., 1960).

A general expression is derived for the evaluation of the pressre distribution, on the surface of a semi-infinite rigid wedge, due to multipole point source. The derivation makes use of a Green's unction constructed by means of spectral representations. The pecial cases of dipole and quadripole fields are worked out in detail.

1799 SCATTERING OF SOUND BY ISOTROPIC TURBULENCE OF LARGE REYNOLDS NUMBER.
.W.Ford and W.C.Meecham.
. Acoust. Soc. Amer., Vol. 32, No. 12, 1668-72 (Dec., 1960).

Lighthill (Abstr. 3372 of 1952) has given an expression for the ntensity of acoustic radiation scattered from turbulent fluids. He finds that such scattered energy is proportional to the square of the Mach number of the turbulence and is also proportional to the value of the turbulence spectrum function at wave number equal to the magnitude of the change in the wave vector during the scattering. If it is supposed that the turbulent region has a Reynolds number sufficiently large to give rise to an inertial subrange, one can use similarity principles to obtain information concerning the spectrum of the scattered radiation. This is accomplished by the use of a Lagrangian-type of space-time velocity correlation in order to treat properly convective effects of the macro-eddies. The result is that the position of the maximum of the scattered power spectrum is shifted from the incident frequency by an amount determined by the Doppler shift due to the mean flow. The half-width of the spectrun is proportional to the turbulence Mach number. The maximum of the spectrum is also proportional to the turbulence Mach number and to $(\omega_0)^{-2/3}$, where ω_0 is the angular frequency of the incident wave.

1800 ON THE MATHEMATICAL THEORY OF WOODWIND FINGER HOLES. A.H.Benade.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1591-1608 (Dec., 1960).

The acoustical effects of open and closed finger holes on woodwind bores in the lower two playing registers are investigated in a mathematical formulation which permits a coherent and comprehensive understanding of the interaction of holes with the bore of a woodwind. Results are expressed in a way which permits accurate engineering calculation of all effects which are dicsussed. It is shown that when the holes are closed at their outer ends, the system is simply and accurately representable by an adaptation of standard transmission line theory for a tube with side branches. Interestingly, this representation is only possible for musically usable hole sizes and spacings. A related formulation is also possible for a sequence of open finger holes: once again the accuracy of the formulation is greatest for musically usable holes. The part of a woodwind bore that is provided with closed side holes functions as a low-pass filter. Similarly the open holes lower down on the bore function as a high-pass filter. The positions of both cutoff frequencies depend critically upon the hole sizes and spacings. Both fall at frequencies which allow them to play a role in the tone production. Methods are given for calculating "end corrections" for bores with some open and some closed holes as well as for bores with some open and some closed holes as well as for bores with perturbations to the bore cross-section. The effects of "misplaced" or "mis-sized" holes are investigated by these methods, and the position of the lowest open hole calculated. An estimate of the errors in these calculations shows them to be essentially exact for musical purposes. The radiation behaviour of a row of open finger holes is analysed. Frequencies below the "cutoff" of the open hole system are radiated essentially isotropically, while each of the higher components is emitted with its own pattern, all of which are roughly conical, in analogy with the shock wave produced by a supersonic projectile. The musical implications of this are discussed briefly. Light is shed on the function of the bell on woodwind instruments, and on the reason why a bell is not needed on certain of them. The dominant role of the "closed-hole" properties of a bore with finger holes is stressed throughout the paper.

Noise . Architectural Acoustics

1801 CONCERNING THE NOISE OF TURBULENT JETS. A.Powell.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1609-12 (Dec., 1960).

The suggestion that the noise generators of turbulent jets undergo convection effects which are limited in such a way as to follow a similarity behaviour leads directly to a resolution of Lighthill's paradox (Abstr. 3372 of 1952; 3188 of 1954), namely, the problem of accounting for the noise power depending upon the eighth power of the jet velocity simultaneously with the gross directional bias. This hypothesis is shown to be at least plausible to a first approximation owing to the general velocity field of the jet having typical dimensions comparable to a fraction of a wavelength; an important corollary is the expectation of appreciable refraction effects. Aspects relevant to the directional peaks of the higher frequencies being less pronounced and located further from the jet axis, and of the slow frequency rise, are briefly discussed.

OPTICS . PHOTOMETRY

1802 CRITICAL EXAMINATION OF THE FUNDAMENTALS OF OPTICS. V.Ronchi.
Atti Fond. Ronchi (Italy), Vol. 15, No. 5, 437-48 (Sept.-Oct., 1960). In Italian.

A critical examination of the three fundamental concepts of optics — light, colour and image — evidences the purely psychic nature of the visual response to a physical stimulus, mediated by a physiological process. A brief survey of the evolutions of such concepts shows how the misleading opinion has been established that one may speak of standard light, of standard colour and of standard images, optics becoming, consequently, a physical science. The author emphasizes that the study of optics should be performed along more appropriate lines.

1803 A SURVEY OF THE WORK OF THE INSTITUTE OF OPTICS [PARIS]. P.Fleury, A.Arnulf and A.Maréchal.
Rev. Opt. (France), Vol. 38, No. 11, 505-24 (Nov., 1959). In French.

Brief descriptions of the following: organization of the Institute; principal apparatus and instruments available; recent and current work on optical image assessment; the course in applied optics at the College of Optics (École Supérieure d'Optique).
W.T.Welford

1804 THE PHOTON AS WAVE OR PARTICLE. P.M.Duffieux.
Rev. Opt. (France), Vol. 38, No. 12, 563-8 (Dec., 1959). In French.

A general discussion of the wave and particle aspects of light, particularly in relation to instrumental optics; it is concluded that present knowledge is insufficient for a complete harmonizing of these aspects.
W.T.Welford

DETERMINATION OF THE VELOCITY OF LIGHT FROM O_2 MICROWAVE ABSORPTION. See Abstr. 837

1805 PHOTOELECTRIC PHOTOMETRY. H.J.J.Braddick.
Rep. Progr. Phys. (GB), Vol. 23, 154-75 (1960).

The development of photoelectric devices has occasioned considerable changes in all types of instrument in which intensities are measured or compared. These devices are directly sensitive to flux and the optical systems used with them must be designed accordingly. At very low intensities the photomultiplier cell allows a light flux of only a few quanta per second to be measured and the theoretical limitations and practical arrangements are discussed. In the ultraviolet spectrum, the photoelectric technique must be revised, but efficient detectors for the whole region are known and some are described. Infrared detection requires recourse to the "internal" photoelectric effect in semiconductors, and the properties of the most important detectors of the class are briefly described. A characteristic advantage of photoelectric detectors is that their output is linearly related to the intensity of the incident light and is in a form suitable for electronic data processing by analogue or digital methods. Some examples in industrial and astronomical photometry which make use of this property are described, and there are some notes on precision photoelectric photometry as used in the maintenance and use of standards of radiation.

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

1806 WAVE-THEORETIC AND RAY-THEORETIC CONTRAST TRANSMISSION FUNCTIONS. E.H.Linfoot.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 870-90 (Dec. 1, 1960).

Optical designers have always had reason to be interested in the question: how well can the practical performance of optical systems be predicted from calculations based on geometrical optics? A large number of experimental investigations have indicated that the scalar wave theory (Huyghens—Kirchhoff diffraction theory) can predict the intensity distribution in the image of a point object well enough for the purposes of instrumental optics. Thus a natural approach to the above question is to consider how well ray-theoretic evaluations of image quality agree with those based on the scalar wave theory. In those favourable cases where the agreement is good, that is to say where the effects of diffracti can be disregarded without introducing unacceptably large evaluation errors, geometrical optics can be expected to provide and ad quate basis for practical optical design. The problem of delimitir the favourable cases then arises.

1807 QUANTITATIVE MEASUREMENT OF ABERRATION BY RONCHI TEST. I.Adachi.
Atti Fond. Ronchi (Italy), Vol. 15, No. 5, 461-83 (Sept.-Oct., 1960).

The Ronchi test is very convenient for analysing aberrations c account of its simple arrangement. When a low-frequency screen is used, the geometrical treatment is permitted and it is easy to measure the aberrations. Some examples are given. The test is superior in measuring asymmetrical aberrations and in its precisi in comparison with the Hartmann test.

1808 BISPHERICAL SURFACES AS AIDS TO ABERRATION CORRECTION IN PHOTOGRAPHIC OPTICS. H.E.Fin
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961), p. 179-84. In German.

The bispherical surface consists of two portions of spheres, both centred on the axis of the optical system and meeting in a rin concentric with the axis. An F/2.8 objective was computed with large zonal spherical aberration and the zonal correction was the improved by redesigning with a bispherical surface; the Strehl intensity was computed to demonstrate the improvement.
W.T.Welfo

1809 A STUDY OF REFRACTIVE INDEX TOLERANCES IN OPTICAL SYSTEM WITH AN ARBITRARY NUMBER C SURFACES. J.Klebe.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961), p. 185-91. In German.

Gives differential formulae and a numerical example for effe of refractive index variation on conjugate position and magnificati (See also Abstr. 1027 of 1960).
W.T.Welfo

1810 A GROUP OF REFLECTING MICROSCOPE OBJECTIVES WITH DIFFERENT CENTRAL OBSTRUCTION RATIOS. H.Riesenberg.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 c 1961), p. 218-28. In German.

Three catadioptric and one purely reflecting objectives havin NA about 0.65, central obstruction ratio for NA ranging from 35% 48% and magnification from 40 to 70, are compared with a flat-field refracting objective for colour correction and contrast trans function; a loss at low frequencies and gain at high frequencies is shown with central obstruction. Photomicrographs are given sho this emphasis of higher frequencies, and microphotometer traces the point spread function obtained from photographs are also giv
W.T.Welf

1811 MEASURING THE CONTRAST TRANSFER FUNCTIO [CTF] OF OPTICAL SYSTEMS. K.Rosenhauer.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 c 1961), p. 260-85. In German.

Detailed description of a test-bench for measuring CTF, in which the object is a square-wave transparency on a rotating dru and the CTF is displayed on an oscilloscope. Results of a large number of measurements on miniature camera objectives and on telescopes are given, for different field angles, focal settings, st settings and wavelengths.
W.T.Welf

1812 EXPERIMENTAL AND PRACTICAL ASPECTS OF TH CONTRAST TRANSFER FUNCTION [CTF]. E.Ingelstam.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 1961) p. 286-98. In German.

Two arrangements for measuring CTF are described; in the first, for lenses, the image of a point source produced by a lens scanned by a disc with a periodic pattern (Siemens star) and the transmitted light signal is used to give an oscilloscope display o

TF. The second arrangement is for photographic emulsions; the nage of a slit is moved across the emulsion by means of a rotating irror and the light passing the slit is modulated periodically by a olarizing device. The resulting photographic image is measured to ive the CTF of the emulsion. Results of measurements made on oth apparatuses are given. W.T.Welford

1813 MEASUREMENT OF ABERRATIONS OF PHOTOGRAPHIC OBJECTIVES BY MEANS OF THE TWYMAN NTERFEROMETER. J.Reichardt and H.Wetzstein.
Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 961), p. 313-24. In German.

A review of the use of the direct interferogram for wave berrations and the dupligram for ray aberrations; results of easurements on an F/2.8 80 mm lens are given in detail with a omparison of the times required for evaluating the ray aberrations y different methods. W.T.Welford

1814 THE POSSIBILITIES OF REALIZING OPTICAL SYSTEMS FOR THE MEDIUM AND FAR INFRARED ITH ARTIFICIAL SYNTHETIC SINGLE CRYSTALS.
.Lachenaud.
ev. Opt. (France), Vol. 38, No. 12, 541-55 (Dec., 1959). In French.

Earlier designs of corrected lenses using coated rocksalt and n achromatic silicon—germanium combination are described. Refractive indices and dispersions are listed for KRS5, CsBr, NaCl, nd AgCl; designs are given for (1) a lens using the first three and orrected for spherical and chromatic aberrations, aperture ratio /2; and (2) a triplet lens in KRS5 corrected at f/2.38 and $\lambda = 11\,\mu$ for pherical aberration, coma and curvature of image. G.F.Lothian

1815 THE ULTROTOME ULTRAMICROTOME — BASIC PRINCIPLES AND SUMMARIZED DESCRIPTION OF CONSTRUCTION. B.Hellström.
cience Tools (Sweden), Vol. 7, No. 2, 10-17 (Aug., 1960).

1816 SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1957.
Handb. Nat. Bur. Stand. (USA), No. H28(III), 66 pp. (1960).

Includes standards for microscope objective and nosepiece hreads (0.800-36 AMO); photographic equipment threads, and urveying instrument mounting threads. Details are given of merican standard rolled threads for screw shells of electric amp-holders.

1817 MICROTECHNIQUE FOR THE INFRARED STUDY OF SOLIDS. DIAMONDS AND SAPPHIRES AS CELL MATERIALS. E.R.Lippincott, F.E.Welsh and C.E.Weir.
Analyt. Chem. (USA), Vol. 33, No. 1, 137-43 (Jan., 1961).

A microtechnique is described for obtaining the infrared spectra 2-35 μ) of solids and corrosive liquids, utilizing sample weights as ow as 4 μg. The cell uses diamond or sapphire as window material. he visible and ultraviolet regions can also be studied. Spectra are btained routinely, easily, and rapidly without many of the limiations inherent in other procedures. So far as is known, the method s applicable to all solids.

1818 DIGITAL RECORDING FOR SPECTRUM ANALYSIS. F.S.Brackett.
. Opt. Soc. Amer., Vol. 50, No. 12, 1193-1200 (Dec., 1960).

Digital recording of spectra on magnetic tape in computer ormat is described and illustrated. The density of points required nd the resulting volume of data are considered both as to the needs or computation and for spectral representation. For maximum esolution in wavelength or frequency, digital discrimination should ecognize intervals of less than one-tenth the spectral slit width. t least five points for each interval is suggested. Noise reduction y computer averaging of points within each interval is shown.

1819 DIRECT DETERMINATION OF LINE SHAPES OF ROTATIONAL SPECTRA FROM INTERFEROMETRIC MEASUREMENTS. T.Williams.
. Opt. Soc. Amer., Vol. 50, No. 12, 1159-62 (Dec., 1960).

It is shown that all the structure present in the interferogram f an "ideal" rotational spectrum consisting of many equally-spaced, identical lines is contained in a sequence of "signatures" at path ifferences of 0, 1/(2B), 2/(2B), ..., where B is the reciprocal of nertia. For a symmetric line shape the signatures are all symetric and homologous, the central one being upright and all successive ones inverted; but asymmetry in the line shape introduces increasing asymmetry in the successive signatures. This agrees with experience. Further, by measuring two vertical distances on each signature one may determine as many harmonics of the line shape as there are signatures. As an example, a typical run of the large interferometric modulator at The Johns Hopkins University is so analysed.

1820 NEW DEVELOPMENTS IN INTERFERENCE SPECTROSCOPY. P.Jacquinot.
Rep. Progr. Phys. (GB), Vol. 23, 267-312 (1960).

After an introduction dealing with the different possibilities of classifying the methods of interference spectroscopy, the more recent developments in Fabry—Perot spectroscopy are described. A complete theory, including the role of surface imperfections and of field diaphragm, is given, and the recent improvements in dielectric coating are reviewed. A complete outline of the photoelectric use of the Fabry—Perot "spectrometer" is given, including: methods of scanning for low and high resolutions, best compromise between luminosity and resolution, calculation of the luminosity and extensions of the Fabry—Perot method to studies of absorption spectra. The properties of a new "spherical" Fabry—Perot spectrometer are described. Some recent results obtained with photographic methods are briefly discussed. A new type of spectrometer is described which selects the different wavelengths by the amplitude of the modulation given to them by a linear variation of optical path. Such an instrument using gratings, for instance, is capable of yielding the same resolution as would be obtained if one of the gratings was used in a conventional fashion with very narrow slits, but it provides a much higher luminosity. The spectrum is directly recorded in the usual form. Methods are also given of selecting the different wavelengths by the frequency of their interferometric modulation: the spectrum is not directly given in the usual form, but in the form of interferogram which is the Fourier transform of the spectrum. The main advantage of these methods is that, in common with the photographic method, the time required for recording the interferogram does not depend on the width of the spectrum studied. The resolving power and the luminosity of the process are studied. Some methods of application are described, as well as the different methods of reconstitution of the spectrum from the interferogram. Some recent applications of Michelson's method of "visibility of fringes" are also reviewed.

1821 TWO DEVICES FOR MICROSPECTROMETRY WITH SPECTROPHOTOMETERS. K.H.Brauer and F.Fröhlich.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961 p. 374-6. In German.

The devices are designed for use with the Jena universal spectrophotometer. One (Abstr. 9415 of 1959) makes possible absorption measurements on micro-objects or on small areas of thin planar samples as a function of a coordinate in the object plane. The second device, chiefly described here, makes possible the latter type of observation on samples up to several millimetres in thickness, by placing them immediately behond the exit-slit of the monochromator. Details of this device are given, and its use is illustrated by an example. J.Sheridan

1822 FILTER MONOCHROMATOR WITH GRADED WAVELENGTH INTERFERENCE FILTER.
J.Krochmann and F.Schwarzkopf.
Lichttechnik (Germany), Vol. 12, No. 11, 613-16 (Nov., 1960). In German.

Interference filters in which the wavelength of maximum transmission varies from one end to the other are now available for the ranges from 400 to 700 and from 700 to 1000 nm and one of these may be used in a simple optical system as a monochromator. The breadth of the transmission band to one-tenth intensity is about 45 nm for a maximum transmission of 40 per cent, but the purity can be increased, with a corresponding loss of transmission, by using two filters in series. The use of such a monochromator for determining, for instance, the spectral reflection curve of a surface is described. J.W.T.Walsh

SPECTRAL WAVELENGTH AS LENGTH STANDARDS.
See Abstr. 1722

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

1823 OPTICAL PROPERTIES OF THIN FILMS. O.S.Heavens.
Rep. Progr. Phys. (GB), Vol. 23, 2-65 (1960).

The optical behaviour of a surface carrying a transition layer is discussed as a problem in scattering. The results are given of the application of electromagnetic theory to the case of a single parallel-sided film. Methods are given for extending this treatment to the case of multiple parallel-sided layers. Both analytical and graphical solutions are considered. Features governing the design of certain multilayer systems are given. A survey is made of the many methods now available for the determination of the thickness and optical constants of materials in the form of thin films. The range, accuracy and conditions of application of the various methods are summarized. A selection of the results obtained on a range of metallic and dielectric films is made and the basis of interpretation of these results is given. It is shown that the apparently anomalous variations of the optical constants of metal films with film thickness can be attributed to the granular nature of such films. Although less spectacular variations are observed in the properties of dielectric films, it is seen that for some materials the optical behaviour suggests the presence of marked inhomogeneity and anisotropy. Films formed chemically and electrolytically are briefly mentioned. Recent methods of controlling the thickness of films during deposition are given, together with a selection of the more important applications of thin films in optics. These include anti-reflecting and high reflecting systems, narrow-band, wide-band and cut-on multilayer filters, the use of thin films in polarizing systems and the application of thin films in heat-absorbing systems.

1824 INTERFEROMETRIC MEASUREMENT OF SMALL ANGULAR DISPLACEMENTS. II. THE DOUBLE-PASSED JAMIN INTERFEROMETER. P.Hariharan and D.Sen.
Brit. J. appl. Phys., Vol. 12, No. 1, 20-4 (Jan., 1961).

For previous work, see Abstr. 5178 of 1960. When the rays emerging from a Jamin interferometer are reflected back through the instrument, fringes similar in appearance and behaviour to three-beam fringes are obtained. These fringes can be used to measure small angular displacements of one of the beam-dividing plates, with an accuracy of the order of 0.01 in. A modified set-up is also described with which angular displacements of a comparatively light, auxiliary mirror can be measured with the same degree of accuracy.

1825 SOME FURTHER NOTES CONCERNING THE LOSS OF ENERGY BY DIFFRACTION IN A SPECTROGRAPH. J.Junkes.
Atti Fond. Ronchi (Italy), Vol. 15, No. 5, 526-36 (Sept.-Oct, 1960).

For previous work, see Abstr. 10772 of 1960. The energy defect in the focal image at coherent illumination of the slit of a spectrograph can be explained by the diffraction pattern being limited by the aperture of the collimator. If this diffraction pattern on the collimator is considered as being of the classical Fresnel type, a discrepancy results between the energy captured by the collimator and that found in the focal image. This difference disappears when the optical intervention of the collimator is taken into account. For this purpose it is suggested that one consider the diffraction pattern as existing not on the collimator plane but on its osculating sphere. Accordingly a new mathematical approach is proposed which, on account of the parameters used, is similar to an inverted derivation of the Fraunhofer image in the focal plane.

1826 THE DIFFRACTION THEORY OF ABERRATIONS. B.Schnabel.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961), p. 176-8. In German.

To facilitate computations at large field angles with vignetted pupils, it is proposed to integrate over a suitable domain of the plane containing the exit pupil, rather than over the reference sphere.
W.T.Welford

SCALAR DIFFRACTION BY A PROLATE SPHEROID AT LOW FREQUENCIES. See Abstr. 371

1827 RULING ERRORS IN REFLECTION GRATINGS. H.Böttcher and M.Schubert.
"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961), p. 82-8. In German.

Theoretical. The effects of small errors in spacing in an echelette grating are investigated with the assumption that the deviations of rulings from the correct positions follow a Gaussian distribution. It is found that the distribution among orders of a given wavelength is slightly changed and in addition there is a general diffuse light flux, the "opalescence field", over a wide range of angles of diffraction.
W.T.Welford

1828 ATTAINMENT OF HIGH RESOLUTION WITH DIFFRACTION GRATINGS AND ECHELLES. G.R.Harrison and G.W.Stroke.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1153-8 (Dec., 1960).

The availability of increased resolution, dispersion, and luminosity from plane gratings at high angles of incidence and diffraction is discussed from the standpoints of theory and practice. Reduction in the resolution given by actual gratings at angles above a certain maximum for a given wavelength usually arises from close-lying line-satellites originating from ruling defects. Variation of satellite displacements and intensities with wavelength gives rise to such undesirable effects as error of coincidence. The bright 10 in. gratings now produced by the M.I.T. interferometrically controlled engine can be used effectively at very high angles (12th-order green from 7500 grooves per inch), but as in all gratings the angle above which resolution fails to increase further diminishes with decreasing wavelength. The pattern dimensions and intensities of satellites are here discussed, qualitatively as they affect resolution in various spectral regions, and are quantitatively discussed elsewhere. The use of gratings and echelles in series for increasing spectroscopic efficiency is discussed, and spectrograms made with two echelles thus used are shown. Two gratings used in series transmit only a narrow wavelength range at one setting because of the wide angular spread of the beam from the first disperser. An echelle beam, on the other hand, spreads but little, and can be caught on a second echelle to give broad spectral coverage. Two echelles used in series give high speed and resolution without the careful relative adjustment required to produce a satisfactory grating mosaic.

1829 VARIABLE DEPTH ECHELETTE GRATINGS. T.Sakurai.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 4, 352- (Aug., 1959).

In the far infrared spectroscopy, the echelette gratings are widely used not only as a dispersive medium but also as filters for short wavelength spectra. There are difficulties, however, that too many kinds of gratings must be provided for the measurement of a wide spectral region, because the optimum of the wavelength for a single grating is quite limited. These difficulties will be removed by making the depth of the grating variable. For the far infrared radiation, such mechanisms can be constructed and operated with sufficient accuracy.

1830 INTENSITY DISTRIBUTION OF THE RADIATION DIFFRACTED BY THE VARIABLE DEPTH ECHELETTE GRATINGS. S.Takahashi.
Sci. Rep. Res. Insts Tohaku Univ. A (Japan), Vol. 12, No. 1, 80- (Feb., 1960).

Taking the effect of the wavelength into consideration, formulae for the intensity distribution of the light, diffracted by various kinds of variable depth echelette gratings have been derived from the Kirchhoff theory. The formula for the variable single depth echelette (VSDE) grating agrees with the formulae which have hitherto been derived for an ordinary echelette grating, except for a normalization constant. It has been made clear that this constant is inversely proportional to the wavelength. The operation of the VSDE grating slightly away from the blaze, gives the light of the desired wavelength effectively in a wide spectral region, reducing the intensities of the higher order spectra. Resolving power is proportional to the width of plate and becomes larger with the increase of the order. By adding rotation to the VSDE grating, it can serve as a dispersive medium as well as a filter for the higher order spectra at the same time. Variable depth filter grating is its special case. By means of a variable double depth echelette grating which has a depth ratio of 2m-1 : 1, it is possible to eliminate perfectly the light with the wavelength which is 1/m of that of the light wanted.

1831 FOURIER IMAGES. IV. THE PHASE GRATING. J.M.Cowley and A.F.Moodie.
oc. Phys. Soc. (GB), Vol. 176, Pt 3, 378-84 (Sept. 1, 1960).
For Pt III,see Abstr. 5960 of 1957. The nature of the Fourier ages obtained from phase objects is investigated theoretically th for the particular case of the sinusoidal grating and also for e general two-dimensional periodic object. The results are rified experimentally with light optics using a two-dimensional ase grating of 50 μ periodicity. A detailed investigation is made the intensity distribution on planes mid-way between, and in the mediate neighbourhood of, Fourier image planes. While there is contrast on the Fourier image planes themselves, it is shown at a simple relationship exists between the pattern on neighbour- g planes and the phase distribution in the general two-dimensional ject. It is shown that there will be no moiré effect at full aperture r phase gratings effectively in contact. Analogies with the scatter- g of electrons by thin crystals are pointed out and it is indicated at under certain conditions a representation of the charge distribu- on will be obtained with modern electron microscopes. Full con- deration of this point is deferred.

1832 REMOVAL OF SCREEN STRUCTURE FROM PHOTOGRAPHS BY OPTICAL FILTERING. M.Marquet.
ptica Acta (Internat.), Vol. 6, No. 4, 404-5 (Oct., 1959). In French.
The process screen structure can be removed from the image a half-tone transparency by re-photographing in coherent illumi- tion, a filter being placed at the image of the source. The filter nsists of a pattern of opaque dots placed so as to obscure the Abbe ectra of the source produced by the half-tone pattern. Photo- aphs illustrating the effect are given. W.T.Welford

1833 THE LIGHT SCATTERING ON HEMISPHERICAL PARTICLES. G.Ciobanu.
ud. Cercetari Fiz. (Roumania), Vol. 10, No. 3, 449-56 (1959). In umanian.
Light scattering was studied using the integral equation of attering. It is shown that deviations from the case of the sphere pear especially for large particles. The cases of light falling ong the axis of the hemisphere were analysed and compared with e corresponding ones for the sphere. The polarization of the attered light is also discussed. The results are appliable to electric scattering particles, slightly differing from the surroun- ng medium and with an order of magnitude smaller or compara- ble to the wave length of the incident light.

BACKSCATTERING FROM A CONDUCTING CYLINDER WITH SURROUNDING SHELL. See Abstr. 373

1834 NEW DESIGN OF SPECTROPOLARIMETER. E.J.Gillham and R.J.King.
sci. Instrum. (GB), Vol. 38, No. 1, 21-5 (Jan., 1961).
A new design of spectropolarimeter is described, in which the nctions of monochromator and polarimeter are combined by using o crystalline quartz prisms both to disperse the radiation and to larize it. The two prisms are fixed in position, wavelength anning being achieved by the rotation of two plane mirrors in ison about a common axis. The optical rotation of the specimen compensated by means of a Faraday cell and is thus measured in rms of current. The present experimental system can be used er a wavelength range from 600 to 220 mμ, the full-scale reading rying with wavelength, being equivalent to about 0.1° at 600 mμ d rising to about 1.1° at 220 mμ. The output noise level is tween about 0.1 and 0.5% of the full-scale rotation over this ectral range.

HEAT . RADIATION

1835 THE TEMPERATURE FIELD PRODUCED IN THE GROUND BY A HEATED SLAB LAID DIRECT ON ROUND, AND THE HEAT FLOW FROM SLAB TO GROUND. Vuorelainen.
ate Inst. Tech. Res. Publ. (Finland), No. 52, 60 pp. (1960).
The mathematical equations of the temperature distribution eld produced by a warm floor slab in the underlying homogeneous, otropic ground have been solved and the heat quantities flowing om the slab to ground, in the stationary state, have been calculated for slabs of rectangular form, of the shape of a narrow strip, and of circular shape. In the solutions those boundary conditions have been found which are most appropriate for use in cases occurring in actual practice. Non-stationary temperature fields for which the surface temperature of the slab of the thermal flow from the slab to the ground is known as a function of time are presented for a slab having the shape of a narrow strip. The equations can also be employed to calculate the field, varying with time, which exists in the vertical section in the middle of an elongated, rectangular slab. Fourier's and Hankel's transformations have been employed in the solutions and the unknown functions involved have been found by means of a systematic procedure, e.g. as solutions of dual integral equations.

1836 ON THE TRANSPORT OF HEAT OR OF MATTER IN THE TURBULENT REGION. E.Ruckenstein.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 3, 347-54 (1958). In Roumanian.
An equation is established for the heat transfer coefficient. The problem of the transfer of matter towards a solid surface is solved for the case of this transfer being accompanied by a chemical reaction with the solid surface. R.Berman

1837 METHOD FOR CALCULATING BOUNDARY VALUE PROBLEMS IN HEAT CONDUCTION FOR THE CYLINDRICAL CAVITY AND THE HALF SPACE, BY MEANS OF CONVOLUTION INTEGRALS. D.W.Jordan.
Brit. J. appl. Phys., Vol. 12, No. 1, 14-19 (Jan., 1961).
A convenient method for obtaining approximate solutions to certain types of boundary value problems in heat conduction is by the use of convolution integrals. The method can be used when no analytical solutions exist, or when they are too complicated to apply. An advantage is that attention can be confined to the temperature variation at one point, say, on the surface, whereas finite difference methods require the temperatures over the whole field to be computed. Surface temperatures are principally considered, and a table of the function required for computations relating to a cylindrical cavity is presented.

1838 MEASUREMENT OF THERMAL CONDUCTIVITY BY UTILIZATION OF THE PELTIER EFFECT. II. CORRECTION FOR WIRE RADIATION AND DETERMINATION OF SPECIMEN RADIATION EMISSIVITY.
R.Simon, R.T.Bate and E.H.Lougher.
J. appl. Phys. (USA), Vol. 31, No. 12, 2160-4 (Dec., 1960).
The analysis of Pt I (see Abstr. 12166 of 1959) is extended to correct for radiation of heat from the lead wires. It is shown how the radiation emissivity of the semiconductor specimen can also be determined from the measured temperatures.

THERMAL TRANSPORT IN DILUTE ALLOYS. See Abstr. 920

1839 RADIATIVE TRANSFER OF ENERGY IN THE CORE OF A HEATED TUBE. K.S.Krishnan and R.Sundaram.
Nature (GB), Vol. 188, 483-4 (Nov. 5, 1960).
The expression $(\frac{16}{3})\sigma DT^3$, where σ is Stefan's constant and T the temperature, is derived for the radiational conductivity of the hollow core of a thin-walled tube considered to be a circular cylinder of diameter D and heated in vacuo by passing an electric current through the tube. The expression is compared with that of Bosworth [Heat Transfer Phenomena. New York: John Wiley and Sons (1952)], for the radiational conductivity of a hot gas, and with that of Casimir [Physica, Vol. 5, 595 (1938)] for the lattice thermal conductivity of a dielectric cylinder at low temperatures, and the analogies are discussed. S.Weintroub

1840 MEASUREMENTS WITH A SPECTRAL RADIOMETER. N.Ginsburg, W.R.Fredrickson and R.Paulson.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1176-86 (Dec., 1960).
An f/2.5 spectral radiometer, consisting of telescope and monochromator mounted on a movable head, is described. By comparison with a blackbody standard and appropriate calibration, spectral radiances can be obtained in watts/cm^2-micron-steradian. Observation on many targets indicates a nearly identical radiance for all. Space scans at a given wavelength do give target distinguishability however, and a discussion of possible cause is given. Rapid variations in radiance have been observed, and are still being investigated.

1841 AN AIRBORNE SPECTRORADIOMETER.
L.G.Mundie, D.E.Brown, P.G.Hasell, Jr and D.S.Lowe.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1187-92 (Dec., 1960).

A system is described for acquiring spectroradiometric data concerning objects in space from an airborne platform. The system operates in the 0.25 to 15 μ spectral region; large collecting optics, precise optical tracking, and background discrimination in the entrance optics permit the acquisition of high resolution and sensitivity. Through the use of reflective choppers, dichroic filters, and multiple exit slits, five types of data are acquired simultaneously; these include spectral data in the regions 0.25-0.6 μ, 0.6 to 5 μ, and 5 to 15 μ and radiometric data in the regions 0.25 to 0.6 μ and 0.6 to 15 μ. Calibration techniques are described.

AN ISOTROPIC SPHERE WITH A TEMPERATURE-DEPENDENT COEFFICIENT OF EXPANSION. See Abstr. 1717

1842 SPECTRAL RADIANCE OF SOME FLAMES AND THEIR TEMPERATURE DETERMINATION.
E.E.Bell, P.B.Burnside and F.P.Dickey.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1286-92 (Dec., 1960).

The spectral radiance of several flames in the 2-15 μ wavelength region was measured using a low-resolution infrared spectrometer. The spectral absorptivities were determined, and this information combined with the radiance measurements has led to a determination of the flame temperature. The techniques of measurement and calibration are described including the important effects of the spectrometer slit width and atmospheric attenuation both on the calibration and the measurements.

1843 A PLATINUM RESISTANCE THERMOMETER FOR USE AT HIGH TEMPERATURES.
C.R.Barber and W.W.Blanke.
J. sci. Instrum. (GB), Vol. 38, No. 1, 17-19 (Jan., 1961).

The design and performance of a platinum resistance thermometer for high temperatures are described. The thermometer bulb is 36 mm × 5.5 mm and is contained in a recrystallized alumina sheath 500 mm long and 8 mm in external diameter. The coil is wound from very pure platinum wire (α = 0.003926) of diameter 0.3 mm and is freely exposed to dry air. The coil resistance at 0°C is 1.4 Ω and this permits measurements to the equivalent of 0.002 deg C. The thermometer is found to be stable to this limit on heating it for one hour at 1603°C.

1844 AUTOMATIC PRECISE RECORDING OF TEMPERATURE.
G.S.Ross and H.D.Dixon.
J. Res. Nat. Bur. Stand. (USA), Vol. 64C, No. 4. 271-5 (Oct.-Dec, 1960).

An apparatus is described which automatically and continuously records small temperature changes. The principal components are a platinum resistance thermometer, a modified G-2 Mueller Wheatstone bridge, a direct current amplifier, and a potentiometric, strip-chart recorder. Frequent zero checking is unnecessary because the system is extremely stable. In systems where the general dependence of temperature on time is known, a nearly uniform change of 0.00001 deg C per min is easily discernible over a recording period of 10 min or more. However, the measurement of temperature at any given instant is limited by an inherent electronic noise band of 0.00004 deg C. A similar arrangement, using a thermocouple pair and a potentiometer instead of the platinum thermometer and the Wheatstone bridge, is also described.

1845 PROGRESS IN CALORIMETRY.
Nature (GB), Vol. 188, 787-8 (Dec. 3, 1960).

Report of the fifteenth annual Calorimetry Conference held at Gatlinburg, Tennessee during 7-10 September, 1960. Thirty-one papers were presented and discussed. These covered a wide range which included calorimetry at temperatures as low as 0.1°K and as high as 2800°K, precision reaction and bomb calorimetry, solution calorimetry, application of calorimetry to solid-state problems, application of calorimetry to radiation dosimetry, improvements in temperature measuring devices, and data processing by digital computers.

CHANGE OF STATE

(Solid-state phase transformations are included primarily under Structure of Solids)

1846 AN AUTOMATIC MELTING POINT RECORDER.
L.F.Berhenke.
Analyt. Chem. (USA), Vol. 33, No. 1, 65-7 (Jan., 1961).

The automatic recording of the movement of a small thermocouple piston, supported by the unmelted solid in a capillary, as a function of temperature is the basis of this instrument. It is fast and simple to operate, requires only milligrammes of sample, and does not require critical control of the heating rates. The records results compare favourably with those from subjective observation

1847 NOTE ON THE BEHAVIOUR OF A VAPOUR–LIQUID SYSTEM ABOVE AND BELOW THE CRITICAL POINT
P.H.E.Meijer.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 303-6 (Aug., 1960).

On the basis of the van der Waals equation it is shown that the maxima in the specific heat at constant pressure (infinite below the critical point and finite above) lie on one continuous line through the critical point. Experimental data fit the curve, above as well as below the critical point, although the van der Waals equation is known to be not entirely correct. The calculation is based on the rules of Ehrenfest for higher-order transitions and does not make use of the caloric properties of the substance.

1848 PHASE EQUILIBRIA IN CONDENSED MIXTURES OF ARGON AND XENON. R.Heastie and C.Lefebvre.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 180-4 (Aug., 1960).

The solid–liquid phase equilibrium diagram of argon and xenon was determined within a limited composition range. A eutectic point exists at a temperature 1.5° below the triple-point temperature of argon and at a composition of 23 mole % Xe. At this temperature argon and xenon are insoluble in the solid state over the composition range 2.7-62 mole % Xe. The results are consistent with the predictions of the cell theory of solutions. The vapour pressure of solid xenon and triple-point data of xenon are reported.

1849 VAPOR PRESSURE OF LEAD AND GERMANIUM SULPHIDES. K.Sudo.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 1, 54-61 (Feb., 1960).

As a part of fundamental researches in distillation process, the vapour pressure of lead and germanium sulphides was measured in the range 775° to 920° C and 433° to 596° C, respectively, by using the Knudsen method. From the results obtained, the following experimental formulae were derived for representing the relation between the vapour pressure and temperature:

$$PbS(s) = PbS(g), \quad \log p_{(atm)} = 7.448 - 11780\,T^{-1}$$
$$GeS(s) = GeS(g), \quad \log p_{(atm)} = 6.215 - 6966\,T^{-1}$$

By using the above data and other thermodynamic values of metallic sulphides, a brief discussion is made on their behaviour in the processes of reducing smelting.

1850 ON THE VAPOUR PRESSURE OF POLONIUM AT ROOM TEMPERATURE. J.Ausländer and I. Georges
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 1, 17-23 (Jan.-March, 1957). In Roumanian.

Preliminary results of experiments carried out with nuclear research plates show an order of magnitude of $\sim 0.5 \times 10^{-14}$ mm

1851 THE EVAPORATION OF THORIUM METAL.
D.L.Goldwater and W.E.Danforth.
J. Franklin Inst. (USA), Vol. 270, No. 4, 317-19 (Oct., 1960).

Measurements on the rate of evaporation of thorium metal are reported. At pressures of 10^{-5} torr results were erratic while at pressures lower than 2×10^{-6} torr more consistent results were obtained 5-10 times higher than those previously published for relatively low temperatures. The data gave an approximate heat of evaporation of 140 kcal/mol and a rate (with T in degrees K) of

$$2.3 \times 10^{-9} \exp(-68\,000/T) \text{ g cm}^{-2} \text{ sec.}$$

W.Steckelmac

THERMODYNAMICS

(See also Statistical Mechanics)

1852 MECHANICAL EQUIVALENT OF HEAT APPARATUS. J.McLeod and A.E.Werbrouck.
er. J. Phys., Vol. 28, No. 9, 793-6 (Dec., 1960).
A continuous flow-type mechanical equivalent of heat apparatus iescribed. It consists of two turbines immersed in water and ated with respect to each other by an electric motor. Lucite sing facilitates observation of the energy conversion and pro- es good thermal insulation. In elementary physics laboratories, st students obtained results within 2% of the accepted value.

1853 SIMPLIFICATION OF CARATHÉODORY'S TREATMENT OF THERMODYNAMICS. L.A.Turner.
er. J. Phys., Vol. 28, No. 9, 781-6 (Dec., 1960).
A simplified development of Caratheodory's thermodynamics, ch obviates the principal mathematical complications of the ori- al paper, is presented. A sketch of Carathéodory's treatment is en in an Appendix.

1854 DEFINITION OF THE PERFECT GAS AND ITS RELATION TO THE SECOND LAW OF THERMODYNAMICS. G.Miller and W.Dennis.
er. J. Phys., Vol. 28, No. 9, 796-8 (Dec., 1960).
It is shown that a perfect gas must be defined by two indepen- t statements. Besides $PV = nRT$, either $(\partial E/\partial V)_T = 0$ or $T = \theta$ y be used. The proof shows that the second law will not yield $/\partial V)_T = 0$ from $PV = nRT$ alone, and is given for both the Carnot le and Carathéodory formulations of the second law.

1855 COMMENTS ON BUCHDAHL'S TREATMENT OF THERMODYNAMICS. L.A.Turner.
ier. J. Phys., Vol. 29, No. 1, 40-4 (Jan., 1961).
It is shown that Buchdahl's treatment involves a tacit extension Caratheodory's second axiom, that if such extension be made the oth law becomes a consequence of the other basic assumptions, l that Buchdahl's parameter s, the empirical entropy for a tem, is the same as x_0, the nondeformation coordinate of a ple system related to the system in question.

1856 RELATION BETWEEN MOLECULAR PRESSURE AND INTERNAL PRESSURE. A.Brin and R.Mérigoux.
R. Acad. Sci. (France), Vol. 251, No. 4, 521-2 (July 25, 1960). French.
Various relations are derived between p_m [$=nkT-p$] and $=T(\partial p/\partial T)_V-p$], and other properties of the fluid; for example, $p_m-T\partial p_m/\partial T$. J.Hawgood

LOW-TEMPERATURE PHYSICS

1857 FIFTH ALL-UNION CONFERENCE ON LOW-TEMPERATURE PHYSICS. R.Chentsov.
ekhi fiz. Nauk (USSR), Vol. 67, No. 4, 743-50 (April, 1959).
Russian. English translation in: Soviet Physics—Uspekhi (USA), . 67(2), No. 2, 329-36 (March-April, 1959).
Held in Tbilisi, from 27 October to 1 November 1958. About apers were presented, falling into 4 broad categories: liquid superconductivity, magnetoelectric phenomena, and magnetism.

CRYOSTAT FOR THE MEASUREMENT OF THE OPTICAL NSTANTS OF METALS. See Abstr. 20966 of 1960.

uperconductivity

1858 ISOTOPE EFFECT IN SUPERCONDUCTING LEAD. R.W.Shaw, D.E.Mapother and D.C.Hopkins.
s. Rev. (USA), Vol. 121, No. 1, 86-90 (Jan. 1, 1961).
The present work is a continuation of earlier measurements str. 3508, 4620 of 1959; 12559 of 1960) of the difference in critical fields of superconducting Pb specimens with various isotopic masses. The isotope samples were repurified and the low-temperature behaviour is now more fully understood. The results near T_C are consistent with the relation $T_C = \text{const} \times M^p$, where M is the average isotopic mass, and yield a value $p = -0.478 \pm 0.014$. The measurements at lower temperatures confirm the similarity principle to within approximately 0.1% and indicate that γ, the coefficient in the normal electronic specific heat, is independent of isotopic mass to a similar accuracy.

1859 MAGNETIC FIELD DEPENDENCE OF ENERGY GAP IN SUPERCONDUCTORS. K.K.Gupta and V.S.Mathur.
Phys. Rev. (USA), Vol. 121, No. 1, 107-19 (Jan. 1, 1961).
The dependence of energy gap in superconductors on static magnetic fields is derived in a gauge-invariant way from the theory of Bardeen, Cooper, and Schrieffer (Abstr. 1708 of 1958). It is shown that the gap width decreases with magnetic field approaching the critical value. Optimum conditions are discussed for the observation of such an effect. The decrease in gap width is calculated for two superconductors, Al and Sn, and it is shown that for film thickness between 10^{-4} to 10^{-5} cm, the effect can be large enough to be observable.

1860 DIRECT MEASUREMENT OF THE SUPERCONDUCTING ENERGY GAP. J.Nicol, S.Shapiro and P.H.Smith.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 461-4 (Nov. 15, 1960).
ELECTRON TUNNELING BETWEEN TWO SUPERCONDUCTORS. I.Giaever.
Ibid., 464-6 (Nov. 15, 1960).
Two reports of further work on Giaever's tunnel effect experiment (Abstr. 16949 of 1960). Giaever used Al—Al_2O_3—M sandwiches with M = Pb, In, Al; Nicol et al. used M = Pb. When M = Pb or In, the tunnel current I shows a negative resistance region when the Al is superconducting; from the position and width of this region, the energy gaps 2ϵ in Al and M can be deduced. Nicol et al. found $2\epsilon/kT_C = 4.35$ (Pb) and 1.8 (Al) at 1.0°K. Giaever found 4.33 (Pb) and 3.63 (In) at 1.1°K. Nicol et al. also show that the I—V characteristic obtained when the Al is normal is well fitted by simple theory. R.G.Chambers

1861 ANISOTROPY OF THE ENERGY GAP IN THE PLANE OF BINARY AXES OF TIN CRYSTALS.
P.A.Bezuglyĭ and A.A.Galkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1163-4 (Oct., 1960). In Russian.
The temperature dependence of α_s/α_n (where α_s and α_n denote the electronic components of the absorption coefficient of ultrasonic waves in the superconductive and normal state, respectively) was determined for Sn single crystals between 1°K and the critical temperature. The results obtained provided additional evidence for the anisotropy of the superconducting energy gap in the plane of binary axes of Sn at 0°K. [English translation in: Soviet Physics—JETP (USA)]. M.H.Sloboda

1862 ULTRASONIC ATTENUATION IN SUPERCONDUCTORS. T.Tsuneto.
Phys. Rev. (USA), Vol. 121, No. 2, 402-15 (Jan. 15, 1961).
A general treatment of ultrasonic attenuation of both longitudinal and transverse waves in superconductors, valid for an arbitrary mean free path, is given on the basis of the Bardeen—Cooper—Schrieffer theory (Abstr. 1708 of 1958). The interaction between the ultrasonic waves and electrons is assumed to be given by a self-consistent electromagnetic field. Instead of the customary theory of the attenuation based on the Boltzmann equation, a different formulation is developed using the density-matrix formalism. The ratio of the attenuations in superconducting and normal metals for the longitudinal wave turns out to be approximately independent of the mean free path. The attenuation of the shear wave due to electromagnetic interaction is shown to be very small in the superconducting state.

1863 HEAT CAPACITY OF FERROMAGNETIC SUPERCONDUCTORS. N.E.Phillips and B.T.Matthias.
Phys. Rev. (USA), Vol. 121, No. 1, 105-7 (Jan. 1, 1961).
Heat capacity measurements on two samples from each of the systems $La_{1-x}Gd_x$ and $Y_{1-x}Gd_xOs_3$ show features which are correlated with the reported existence of both ferromagnetic and superconducting transitions. For one sample the measurements cover a wide enough temperature range to show that the entropy

associated with the ordering of the gadolinium spins is the (xR)ln8 expected for complete order. The heat capacities of the other samples are consistent with complete ordering. Superconducting transitions were observed both above and below the maximum in the heat capacity associated with the spin ordering. The entropy differences between the normal and superconducting states show that superconductivity is not confined to small volume elements but probably extends throughout the sample.

FREQUENCY-DEPENDENT HALL EFFECT IN SUPERCONDUCTING METALS. See Abstr. 1011

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

1864 CLASSICAL ELECTRICITY AND MAGNETISM. E.S.Shire.
London: The Cambridge University Press (1960) 396 pp.

The intention of the book is to cover the pass degree course although in the interests of completeness it goes somewhat beyond this level. It joins the very small number of books which attempt to bridge the gap between the multitude of elementary works and such classic works as that of Jean's, and should therefore be of considerable value to the honours student. The treatment is orthodox throughout, including an introduction to Maxwell's equations and electromagnetic waves. There are chapters on measurements and applied electricity. This latter is devoted to machines, electronics, the motion of charged particles and particle accelerators. Copious exercises are provided at the end of each chapter and answers are given. The book concludes with a number of useful appendices, a list of references and an adequate index. In the vexed question of rationalized and irrationalized units the author has introduced the symbol δ into his equations; this can be regarded as 1 or 4π according to taste.

1865 POWER SUPPLY FOR THE e/m EXPERIMENT. R.W.Christy and W.P.Davis, Jr.
Amer. J. Phys., Vol. 28, No. 9, 815-16 (Dec., 1960).

1866 SUBTRACTION SYSTEM WITH A MEMORY CATHODE-RAY TUBE. A.Boucherie.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 354-6 (March, 1960). In French.

Describes a method whereby a digital substracting system is obtained. This system can be associated with a pulse height analyser which uses the principle of storing pulses along vertical lines on the screen of a memory cathode-ray tube and analysing them by horizontal scanning. In this case it leads to a simple way of direct conversion of the integral spectrum given by the scanning into a differential spectrum.

1867 A PROPOSAL TO DECREASE THE DEADTIME OF THE HUTCHINSON–SCARROT TYPE PULSE HEIGHT ANALYSER. W.S.C.Williams.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 361-2 (March, 1960).

The modification to the analyser reduces the dead time by a factor equal to the number of channels. This is done by inserting a temporary stores between input and the normal circulating binary store.

1868 A TWO-DIMENSIONAL PULSE-HEIGHT ANALYSER. A.E.Litherland and D.A.Bromley.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 176-8 (Jan., 1960).

A method is described whereby a 120-channel pulse-height analyser can be converted into three forty-channel pulse-height analysers. This is accomplished by adding three voltage pedestals of different height to the input pulses. The method has been successfully used in a study of the $N^{14}(He^3,p\gamma)O^{16}$ reaction.

1869 A MULTIPLE EVENT ANALYSER. W.G.Gore.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 320-4 (June, 1960).

A circuit is described that produces an output pulse, the height of which is proportional to the number of input pulses received in a given time interval after an input gate pulse. This circuit, when used with a pulse height analyser, enables the distribution of the number of pulses per burst to be analysed. The maximum number of pulses per burst that can be counted is ten.

1870 THE INPUT STAGE OF A TRANSISTOR PULSE AMPLIFIER. A.W.Pryor.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 164-8 (Jan., 1960).

The input signal of a linear amplifier for nuclear detectors is in the form of a charge released in very short time. Under these circumstances a transistor input stage behaves very differently from a valve input stage both in the shaping of the pulse and in the noise conditions. An experimental and semi-theoretical account of the performance of typical r.f. transistors is presented.

1871 A NEW SOLUTION OF THE FINITE RISE TIME PROBLEM BY MEANS OF A DISTRIBUTED AMPLIFIER WITH AUTOMATIC GAIN CONTROL. B.Johansson.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 201-5 (Jan., 1960).

In a distributed amplifier the output pulse is built up by the addition of pulses from subsequent stages. If this sum-up is stopped when the pulses have reached a certain pulse-height level then the output pulses will have the same height and, what is essential in time measurements, the same shape independent of the height of the input pulse within a certain pulse-height range. distributed amplifier based on this principle is described. It consists of 2 cascaded 5 tube-amplifiers (rise-time 8 ns) and covers a pulse-height range of 15 dB. By a conveniently chosen combination of number of tubes and cascaded amplifiers, any desired pulse-height range can be covered. The amplifier can be built for fast as well as slow phosphors.

1872 A FAST COINCIDENCE UNIT OF VARIABLE RESOLVING TIME. J.B.Garg.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 187-92 (Jan., 1960).

A fast coincidence unit of variable resolving time in the range 0-100 ns is described. The unit is designed to accept pulses of either polarity and uses fast discriminators in order to select the amplitude of the input pulses.

1873 ENERGY DEPENDENT INSTRUMENTAL TIME DELAYS IN MILLIMICROSECOND DELAYED COINCIDENCE EXPERIMENTS. E.Bashandy.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 289-95 (March, 1960).

An experimental study of energy dependent time delays present in delayed coincidence measurements has been performed. The most important factor was found to be due to the time lag between the excitation of the scintillator and the appearance of the first few photoelectrons used to trigger the coincidence circuit. These time delays are of the order of 10^{-10} sec and may introduce serious systematic errors when submillimicrosecond lifetimes are to be measured by the centroid displacement method. It is shown that these errors can be eliminated by making use of an electron–electron coincidence spectrometer.

1874 AN ANTI-COINCIDENCE CIRCUIT FOR RANDOMLY DELAYED PULSES. S.Rozenstein.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 213-14 (May, 1960).

An anticoincidence circuit is described consisting of a bistable multivibrator, a delay line and a primed univibrator. Operation is actuated by the leading edges of the incoming pulses. The overall dead time of the system is therefore not affected by this anticoincidence circuit.

1875 A NANOSECOND COINCIDENCE CIRCUIT USING TRANSISTORS. A.Barna, J.H.Marshall and M.Sano
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 124-34 (May, 1960).

A transistor coincidence circuit is described which is intended be used for scintillation counting of high energy particles. etails of the performance of the basic components are given both ith test pulses and with photomultiplier pulses in a counting rrangement. Resolving times as low as 2 nanoseconds were easured.

1876 SOME REMARKS CONCERNING DIFFERENTIAL FAST COINCIDENCE SYSTEMS. M.Maitrot.
Phys. Radium (France), Vol. 20, No. 7, 717-19 (July, 1959). In rench.

A modification of the differential fast coincidence system of ay [Nucleonics, Vol. 14, No. 4, 56 (1956)] was used for liquid cintillation counting employing (a) 53 AVP photomultipliers with stributed amplifiers, and (b) RCA 6810 photomultipliers. A mpler fast coincidence system requiring less gain was also eveloped, with a resolving time of 0.4-0.5 nsec. It is concluded at with the present limitations on photomultiplier transit time uctuations, differential methods offer little improvement over fast incidence techniques, but their interest would be greatly increased ith improved electron optics. J.B.Birks

1877 TRIGGERING OF EZ-10 COUNTING TUBES BY TRANSISTORS. P.F.Gutmann and D.T.Jovanovic.
uclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 206-8 an., 1960). In French.

The authors describe two circuits suitable for the operation of ounting tube type EZ 10. The first of these is a monovibrator upplied by a high voltage transformer and incorporates four trans- stors (PNP and NPN), and operates up to a frequency of 250 c/s ith small consumption. The second circuit is simpler, working n the principle of a blocking oscillator, the transformer of which as an additional high voltage winding; the upper limit of the fre- uency used (50 kc/s) is imposed by the maximum power dissipated the transistor.

1878 ON THE AUTOMATIC CONTROL OF SCINTILLATION SPECTROMETERS. H.W.Taylor and R.McPherson.
uclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 315-19 une, 1960).

A simple control circuit is described which permits the auto- atic control of a scintillation coincidence spectrometer used for rectional correlation studies and coincidence measurements. utomatic sequential pulse-height analysis if obtained by coupling the control unit a 100-position stepper which advances the bias on single channel analyser.

1879 A LINEAR GATE OF 10 TO 100 mμsec DURATION. G.B.B.Chaplin and A.J.Cole.
uclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 45-9 pril, 1960).

A simple and reliable linear gate, which uses two diodes and a ansformer, is described as part of a system which includes a pulse retching amplifier and fast gate-pulse generator. The gate has a witching time of 5 mμsec and accepts input signals with amplitudes nging from 150 mV to 5 V. The amplifier produces output pulses 5 μsec duration with 1% linearity in the range 2 mA to 70 mA. A nstant error of 1 mA at the output is introduced by the gate whilst e signal breakthrough is less than 1% over a wide range of tem- ratures. The appendix includes details of a high-level amplifier hich is suitable for use with present-day pulse analysers.

1880 TIME-TO-AMPLITUDE CONVERTER CAPABLE OF HIGH RESOLUTION.
Gorodetzky, R.Richert, R.Manquenouille and A.Knipper.
clear Instrum. and Methods (Internat.), Vol. 7, No. 1, 50-5 pril, 1960). In French.

A fast time-to-amplitude converter is described which secures liable operation. Its intrinsic resolution is of the order of 10^{-10} sec. e resolution curve for Co^{60} gamma rays exhibits a full width at half ximum of about 4×10^{-10} sec. Further improvements of the paratus are indicated.

1881 A TRANSISTORIZED RING SCALER OF RESOLVING TIME 0.3 μs.
W.Hutchinson, R.Rubinstein and W.H.Wells.
clear Instrum. and Methods (Internat.), Vol. 7, No. 2, 167-73 ay, 1960).

A transistor decade counter is described, employing a ring principle, and capable fo accepting pulses at a minimum separation of less than 0.3 μsec. It includes a discriminator, pulse shaping circuit and a gating circuit. Printed wiring is used throughout.

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

1882 DIGEST OF LITERATURE ON DIELECTRICS. VOLUME 23. 1959. Edited by L.J.Frisco and T.D.Callinan.
Washington: National Academy of Sciences — National Research Council, Publication 799 (1960) 423 pp.

This annual volume is prepared by the Committee on Digest of Literature of the Conference on Electrical Insulation, Division of Engineering and Industrial Research. The papers are: Instrumentation and measurements, H.P.Hall and A.E.Sanderson (1-37) 269 refs. Tables of dielectric constants, dipole moments and dielectric relaxation times, K.H.Illinger (39-68) 80 refs. Molecular and ionic interactions in dielectrics, A.M.Parks, J.Hart and M.O.Poirier (69-99) 171 refs. Conduction phenomena in solid dielectrics, F.R Lipsett and J.Rolfe (101-31) 162 refs. The breakdown of dielectrics, S.I.Reynolds and J.C.Devins (133-60) 179 refs. Ferroelectric and piezoelectric materials, W.R.Cook, Jr and H.Jaffe (161-89) 261 refs. Magnetic materials, J.C.Slonczewski et al. (191-297) 528 refs. Rubber and plastic insulation, S.Palinchak, B.Bennett and C.W.Hamilton (299-342) 150 refs. Insulating films and fibrous materials, H.A.Birdsall (343-64) 79 refs. Insulating liquids and their applications, T.D.Callinan (365-75) 60 refs. Solid inorganic insulation, J.G.Leschen (377-91) 75 refs. Applications, A.J.Warner (393-421) 200 refs.

1883 A NOTE TO RECENT THEORIES OF BROWNIAN MOTION IN NON-LINEAR SYSTEMS. A.Marek.
Physica (Netherlands), Vol. 25, No. 12, 1358-67 (Dec., 1959).

According to three mutually different theories (Abstr. 2167 of 1958; 8564, 7064 of 1960) the mean value of the charge q on a linear capacitor working in parallel to a diode should be $\bar{q} = -e/2$ at thermodynamic equilibrium. A derivation of this result is given here by using two arguments only; the hypothetical form of the current–voltage characteristic of the diode, and the equipartition principle. The opposite result $\bar{q} = 0$, however, is shown to follow from the second principle of thermodynamics. Two other alternative forms of the diode characteristic are suggested. A justification of exactly one of these three forms by experimentation devised is shown to be feasible at the time being.

1884 ELECTROSTATIC FIELD OF A CAPACITOR WITH A DIELECTRIC SLAB. I.M.Minkov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 10, 1207-9 (Oct., 1960). In Russian.

The field distribution in a parallel, circular plate capacitor with a dielectric slab of infinite extent (filling completely the space between the plates) is solved exactly by means of two integral equations, for fields inside and outside the dielectric. The solutions of the integral equations can be obtained by successive approximations, the first of which is given for $r_0 \gg 2h$ (r_0 = radius of plates; 2h = distance between the plates). [English translation in: Soviet Physics–Technical Physics (USA)]. J.K.Skwirzynski

1885 SOLUTION OF THE FIELD IN A CAPACITOR WHOSE PLATES ARE HOLLOW SPHERICAL SEGMENTS.
I.M.Minkov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 11, 1355-61 (Nov., 1960). In Russian.

The problem is solved exactly. The electrostatic field potential between concentric plates and the charge density on the plates are expressed as integrals over an auxilliary function. This function is expanded as a power series and its coefficients are determined by means of simple recurrent equations. [English translation in: Soviet Physics - Technical Physics (USA)]. J.K.Skwirzynski

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

1886 CORBINO DISK. D.A.Kleinman and A.L.Schawlow.
J. appl. Phys (USA), Vol. 31, No. 12, 2176-87 (Dec., 1960).

When a disk with concentric inner and outer electrical contacts is placed in a magnetic field parallel to its axis, and current is made to flow through the disk, the lines of current flow have a spiral shape. This spiral current flow produces its own magnetic field, which interferes constructively or destructively with the applied field, depending upon whether the carriers spiral inward or outward, respectively. For ordinary conductors and ordinary currents the effect of the self-field of the current is very small. But the effect should be large in materials of very high mobility such as has been recently reported for bismuth at 4.2°K. In this paper the theory of the effect is given for the case in which the mean free path of the carriers is small compared to the inner radius of the disk. The analysis shows that the disk behaves as a rectifier. The easy direction of flow corresponds to outward spiralling of the carriers, which at large currents results in the explusion of the magnetic field from the disk. In the hard direction of flow the magnetic field at the centre of the disk may be several orders of magnitude larger than the applied field. It is suggested that the Corbino disk may be a useful rectifier in applications requiring extremely low impedance. It may also be a useful voltage regulator in a very low-voltage high-current power supply. A device consisting of the disk and a coil to provide the magnetic field is discussed in some detail. The static characteristics when the coil is connected through a suitable resistance in parallel with the disk exhibits a negative resistance. This negative resistance is useful in a.c. operation if a condenser is also connected in series with the coil. The equations and boundary conditions which determine the electrical properties of the disk in the time-dependent case are formulated. In the small-signal approximation the complex impedance is obtained for the limiting cases of low and high frequency. At low frequency the reactance is that of a negative inductance ($-i\omega L$). At high frequencies there is a skin effect on the tangential component of current, which causes most of the signal current to be radial and causes the impedance to reduce to the resistance of the disk.

IONIZATION

1887 RECENT APPEARANCE POTENTIAL MEASUREMENTS USING AN ELECTROSTATIC ELECTRON SELECTOR. L.Kerwin and P.Marmet.
J. appl. Phys. (USA), Vol. 31, No. 12, 2071-6 (Dec., 1960).

The general principles of measuring appearance potentials by the electron bombardment method are reviewed. Recent improvements in the design of an electrostatic electron selector so as to improve the electron bombardment technique are described. The new instrument provides an electron beam with an energy spread of less than 50 mV. By means of it, measurements have been made on the vibrational levels N_2^+ and H_2^+.

1888 PHOTOIONIZATION OF ATOMIC OXYGEN AND ATOMIC NITROGEN. A.Dalgarno and D.Parkinson.
J. atoms. terrest. Phys (GB), Vol. 18, No. 4, 335-7 (Aug., 1960).

Computed photoionization cross-sections are given as a function of wavelength of incident radiation between 1 A and 1000 A, together with a brief description of the method of calculation.

D.M.Schlapp

1889 MASS-SPECTROMETRIC INVESTIGATION OF THE PHOTOIONIZATION OF HYDROGEN. E.Schönheit.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 841-2 (Sept., 1960).
In German.

With a condensed discharge in argon at 50 c/s as the light source, H^+, H_2^+, and H_3^+ were produced. The highest yield was in H_2^+. Its ionization potential was found to be 15.42 ± 0.02 eV.

R.Schnurmann

1890 TOWNSEND IONIZATION CONSTANTS IN N-ALKANES. O.H.LeBlanc, Jr and J.C.Devins.
Nature (GB), Vol. 188, 219-20 (Oct. 15, 1960).

The authors show that the first Townsend coefficient α, measured directly for n-alkanes and n-alkyl chlorides, can be related to molecular structure by theoretical equations of the same form. Values of α and the second coefficient γ, indirectly inferred from measured sparking potentials, are shown to depend on the intensity of cathode illumination, and this dependence is attributed to space charge distortion below the Townsend threshold. The Ramsauer cross-sections are examined as functions of the numbers of hydrogen atoms per n-alkane and n-alkyl chloride molecule.

K.A.Thom

1891 MEASUREMENT OF IONIZATION AND ATTACHMENT COEFFICIENTS IN HUMID AIR IN UNIFORM FIELDS AND THE MECHANISM OF BREAKDOWN.
A.N.Prasad and J.D.Craggs.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 223-32 (Aug., 1960).

Measurement of pre-breakdown currents and breakdown potentials in humid air in the E/p range of 30 to 40 V cm^{-1} (mm Hg) at total pressures of 150 and 300 mm Hg with partial pressures of water vapour in the range 2.5 to 15 mm Hg indicate a pronounced increase in attachment compared with conditions in dry air. From the semi-logarithmic plots of current against electrode separation Townsend's ionization coefficient α and an attachment coefficient η were obtained for humid air employing the modified Townsend equations for the growth of current. From the measured breakdown potentials, values of Townsend's secondary coefficient γ were calculated using the modified Townsend breakdown criterion. Further the percentage increase in breakdown potential in humid air was plotted as a function of the partial pressure of water vapour. From similar measurements in pure water vapour at pressures of 10 and 20 mm Hg in the E/p range of 30 to 50 V cm^{-1} $(mm\ Hg)^{-1}$, values of α/p and η/p were obtained for water vapour. A mean cross-section for attachment was computed for various values of mean electron energies assuming a Maxwellian distribution and employing the earlier measurements of drift and agitation velocities.

1892 MEASUREMENT OF IONIZATION AND ATTACHMENT COEFFICIENTS IN CARBON DIOXIDE IN UNIFORM FIELDS. M.S.Bhalla and J.D.Craggs.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 369-77 (Sept. 1, 1960).

The growth of pre-breakdown currents in uniform field conditions was studied in carbon dioxide at different pressures in the E/p range of 1200 to 26 V cm^{-1} $(mm\ Hg)^{-1}$. Experimental measurements of the Townsend ionization coefficient α showed good agreement with the earlier measurements in the E/p range of 1200 to 100 V cm^{-1} $(mm\ Hg)^{-1}$ and with the recent measurements in the E/p range of 70 to 50 V cm^{-1} $(mm\ Hg)^{-1}$. The results showed that earlier measurements neglecting attachment may have been in error below E/p = 50 V cm^{-1} $(mm\ Hg)^{-1}$. It was suggested that the mechanism of negative-ion formation was due to dissociative attachment, consequently the growth of current at constant E/p can be represented by the appropriate modification of the Townsend equation. Employing this equation, values of α and the dimensional equivalent attachment coefficient η were computed. Further, static breakdown potentials were measured up to pd (pressure × gap length) ~ 1500 mm Hg cm and the values of secondary coefficient γ were calculated using the modified Townsend breakdown criterion. From the mean values of α/p and η/p, the mean cross-sections for ionization and attachment were calculated for various electron mean energies and compared with the values computed from low-pressure single-collision data, by assuming either a Maxwellian or a Druyvesteyn distribution of electron energies. It was concluded that neither of these distributions explained the results.

1893 THE KINETICS OF POSITIVE IONS AT THE CATHODE OF A LUMINESCENT DISCHARGE IN MERCURY VAPOUR. E.Bădărău and M.Hagiescu-Miriște.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 3, 429-33 (1959).
Roumanian.

The electron transfer cross-section was studied at the cathode of an anomalous luminescent discharge. The results obtained were in agreement with the determinations made previously by the authors as well as those of other researchers made under different conditions.

1894 RECOMBINATION OF IONS AND ELECTRONS. N.D'Angelo.
ys. Rev. (USA), Vol. 121, No. 2, 505-7 (Jan. 15, 1961).
A process of electron–ion recombination is considered, volving three bodies (one ion and two electrons), in which an ectron, as a result of a collision with another electron, loses ough energy to be captured in one of the excited electronic orbits the ion and then ends in the ground state by emission of one or ore light quanta. It is shown that such a process might account for e large values of the recombination coefficient found experimentally.

ELECTRIC DISCHARGES

1895 SECOND SUPPLEMENT TO BIBLIOGRAPHY ON GASEOUS DIELECTRIC PHENOMENA.
nerican Institute of Electrical Engineers (Sept., 1960) 31 pp. ublication S-97B].

1896 A NEW FORM OF ELECTRIC DISCHARGE OBTAINED BY THE SUPERIMPOSITION OF TWO DIFFERENT SCHARGE FORMS. G.D.Cristescu.
n. Phys. (Germany), Vol. 6, No. 3-4, 153-5 (1960). German.
Superimposing a d.c. or intermittent current on a h.f. torch scharge, a new discharge form is obtained which gives many ssibilities of excitation when used as a spectrum source. The riation of volt–ampere properties with the two discharges is ven. H.Edels

1897 SIMULTANEOUS APPLICATION OF TOWNSEND AND STREAMER THEORY. A.E.D.Heylen.
ature (GB), Vol. 188, 734 (Nov. 26, 1960).
In hydrocarbon gases, space charges reduce the growth of alanches when $e^{\alpha d} > \sim 10^7$. Townsend log i–d plots for isopentane e interpreted by postulating the occurrence of a conventional ownsend secondary mechanism in the streamer-inducing regime. A.E.D.Heylen

1898 GAS MIXTURE PROCESSES IN ALTERNATING CURRENT DISCHARGES. H.Deutsch.
n. Phys. (Germany), Vol. 6, No. 7-8, 355-60 (1960). In German.
An investigation is described of the dependence of the properties an a.c. glow discharge on tube dimensions, current strength, total s pressure, partial pressure and type of gas used. Frequencies of , 400 and 540 c/s with He–Kr, Ne–Kr, Ne/He–Kr and Ne/He–A ixtures were examined. The investigation shows that for sufficient- long tubes several intensity maxima can be obtained. Figures are ven for Kr in Ne–He mixtures for 4 tube lengths. H.Edels

1899 EXPERIMENTAL STUDY OF ARC STABILITY. I. J.D.Cobine and G.A.Farrall.
appl. Phys. (USA), Vol. 31, No. 12, 2296-2304 (Dec., 1960).
The stability of short arcs in gases and in metal vapours is osely related to the phenomena associated with the cathode spot. se is made of improved techniques to study this phenomenon for considerable range of electrode materials. The distribution of c life for a given average current is shown to follow the survival w. These data demonstrate that a small percentage of arcs of a ven current on very clean metal surfaces may have lifetimes that e extremely short or very long compared with the average life. he relation between the average life of an arc and its average rrent is shown generally to consist of two sharply defined sections ch of the form $\ln t = A \ln I + B$. The distribution of lifetimes and e relation between average life and average current are shown r Hg, Cd, Zn, Cu_2Sb, Bi, Bi–Cu, Cu–In, Ag, Cu_3Sn, Al, Be, Cu, –W–Th, Cu–MoC, Mo, and W. It is shown that high vapour essure materials tend to produce more stable arcs than those ving low vapour pressure.

PLASMA

(See also Magnetohydrodynamics)

1900 TOROIDAL APPARATUS WITH STRONG MAGNETIC FIELD "TOKAMAK 2".
V.S.Vasil'evskii, V.S.Mukhovatov, V.S.Strelkov and N.A.Yavlinskii.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 10, 1137-44 (Oct., 1960). In Russian.
A new deuterium-discharge device is fully described, separate sections being devoted to the mechanical, electrical, and pumping arrangements, as well as to the means of introducing measuring instruments without detriment to the discharge. Purity of the gas is enhanced by meticulous cleansing of the internal walls and extra pumping systems designed to ensure low pressure in the residual gas. Further to this end, the internal walls are heated to 400°C. The new apparatus brings the attainment of pure deuterium plasma nearer. [English translation in: Soviet Physics-Technical Physics (USA)]. A.E.I.Research Laboratory

1901 INVESTIGATION OF HARD X-RADIATION IN THE TOROIDAL APPARATUS "TOKAMAK 2".
V.V.Matveev and A.D.Sokolov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 10, 1145-51 (Oct., 1960). In Russian.
Apparatus for detecting X-rays excited in gas discharges (in particular deuterium) and producing oscillograms of their output is described in detail. Curves obtained give the dependence of X-ray output on the ratio of electric field to initial gas pressure (for fixed magnetic field and various electric fields), and its dependence on magnetic field for various combinations of electric field and initial pressure. The energy distribution and time variation of the radiation are found and discussed. Information thus gained leads to a better understanding of the gas discharge process. [English translation in: Soviet Physics-Technical Physics (USA)]. A.E.I.Research Laboratory

1902 THE JOULE HEATING OF A STABLE PINCHED PLASMA. M.G.Haines.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 250-60 (Aug., 1960).
The hydromagnetic equations are employed to obtain the conditions necessary for a pressure balance in a pinched discharge in ionized deuterium. The time-dependent energy equation is integrated to give the time taken to heat the plasma by Joule heating with bremsstrahlung radiation losses only, and with a pressure balance maintained at all time. This heating time is shown to depend on the radius, line density, and final temperature of the plasma. The current density distribution during the heating process is calculated, showing only a small divergence from uniformity. The condition for no run-away electrons to be present at any time during the heating process is shown to place a restriction only on the minimum line density of the particles. The effect of an unbalance of pressure, causing a change in the outside radius of the plasma during the heating process, is discussed. Finally, the utilization of a transient energy source and its relation to discharge parameters is considered.

1903 INSTABILITY MECHANISMS IN TRANSVERSE PINCHES. V.Josephson, M.H.Dazey and R.F.Wuerker.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 416-17 (Nov. 1, 1960).
Internal and external magnetic search coil measurements, and Kerr cell and streak photographs, suggest that the nuclear reactions in transverse deuterium pinches are produced similarly to those in an ordinary pinch. The presence of trapped reverse-sign magnetic field produces a configuration closely similar to that of an unstabilized toroidal pinch. This is subject to m = 0 instabilities, which accelerate deuterons to neutron-producing energies. R.S.Pease

1904 INVESTIGATION OF THE ELECTRON DENSITY IN THE LINEAR PINCH WITH 8.7 mm WAVES.
H.Hermansdorfer.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 979-83 (Nov., 1960). In German.
The plasma cylinder of a fast linear pinch was irradiated radially with a microwave beam (34.4 kMc/s, λ_0 = 8.7 mm) and the phase modulation of the wave reflected by the plasma observed. Though Kerr cell pictures show a strong plasma contraction, the plasma

layer with an electron density of about 10^{13} cm^{-3} (the initial deuterium pressure corresponded to a particle density of 3×10^{15} cm^{-3}), responsible for the reflection of the used microwave, is less than a few millimeters away from the inner wall of the discharge tube.

1905 GAS-INSULATION OF A HOT PLASMA. H.Alfvén and E.Smårs.
Nature (GB), Vol. 188, 801-2 (Dec. 3, 1960).

In a hot gas at high temperatures in a magnetic field, ionic conductivity is dominant. This varies as $T^{-3/2}$ and it is suggested that a hot gas could be used to insulate a plasma from wall effects. Values are derived for the heating power needed to achieve burn-out, resulting in a high central temperature, for two values of applied magnetic field. Such a plasma may not have the same instabilities as a vacuum insulated plasma and it should be clean. A preliminary experiment using an electrodeless discharge in helium in a torus was performed. Streak camera pictures indicate that the plasma ring looks more stable as the gas pressure is increased.

J.W.Sturgess

1906 FORCES ON CHARGED PARTICLES OF A PLASMA IN A CAVITY RESONATOR.
J.W.Gallop, T.L.Dutt and H.Gibson.
Nature (GB), Vol. 188, 397-8 (Oct. 29, 1960).

Two types of confining forces are defined. A chart showing regions of confinement and plasma heating is given. D.Walsh

ARGON PLASMA FLOW. See Abstr. 1970

A CHARGED PARTICLE MOVING THROUGH A PLASMA WITHOUT MAGNETIC FIELD. See Abstr. 1958

ELECTRON EMISSION ELECTRON BEAMS

1907 PHOTOEMISSION AND RELATED PROPERTIES OF THE ALKALI-ANTIMONIDES. W.E.Spicer.
J. appl. Phys. (USA), Vol. 31, No. 12, 2077-84 (Dec., 1960).

The photoemissive process in the semiconducting alkali-antimonides is examined and values are given for the band gaps and electron affinities. The high photoelectric efficiencies of these materials are attributed to the ability of the excited electrons to traverse relatively large distances (250 A) without overwheling energy losses, rather than to negligibly small electron affinities. The efficiency is found to be strongly dependent on the percentage of the electrons which are excited into states above the vacuum level. The properties of these materials depend to a large extent on the crystal structure. Cs_3Sb and Na_2KSb have a cubic structure, are p type, and seem to have a relatively simple valence band structure. K_3Sb and Na_3Sb have hexagonal crystal structures, are n type, and seem to have a relatively complex valence band structure. The evidence for an effect of band bending on the photoemission is considered.

1908 INFLUENCE OF TEMPERATURE ON PHOTOMULTIPLIERS. A.Coche and G.Laustriat.
J. Phys. Radium (France), Vol. 20, No. 7, 719-20 (July, 1959). In French.

Compares spectral sensitivities at –30° C and 20° C. C.D.Cox

1909 SECONDARY EMISSION OF GLASS NO. 46 BOMBARDED WITH POSITIVE IONS. G.M.Batanov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2048-57 (Sept., 1960). In Russian.

Studies are described of electron emission (from filled bands) due to bombardment with H^+, H_2^+, H_3^+, He^+ and A^+ of 200-2000 eV energies. For H_2^+ and He^+, measurements were extended up to 30 keV. The results are discussed in terms of deformation of electron shells and displacement of electron levels by ion bombardment. [English translation in: Soviet Physics–Solid State (USA)].

A.Tybulewicz

1910 CONTRIBUTION OF THOMAS A. EDISON TO THERMIONICS. J.B.Johnson.
Amer. J. Phys., Vol. 28, No. 9, 763-73 (Dec., 1960).

A brief summary is given of the steps in the development of the thermionic vacuum tube. This leads back to the experiments of various people in the early 1880's, and particularly to the attempts by Thomas A.Edison to find the cause of the blackening of his newly developed incandescent lamps. Edison discovered during this work that substantial electric currents could flow between a hot carbon filament and another electrode across a high vacuum. Along with his contemporaries he wrongly ascribed the current to the flow of molecular ions rather than electrons. He, nevertheless, invented and built devices making use of these currents, the first applications of thermionics. The work received wide publicity at the time. Extracts from Edison's notebook and other sources serve as illustrations.

1911 POTENTIAL DISTRIBUTIONS IN A LOW-PRESSURE THERMIONIC CONVERTER. P.L.Auer.
J. appl. Phys. (USA), Vol. 31, No. 12, 2096-2103 (Dec., 1960).

A plane diode model of a low-pressure caesium-filled thermionic converter is treated. It is assumed that all ions and electrons are created at the surface of the hot cathode with a Maxwellian distribution corresponding to the cathode temperature. The charged species are then assumed to move through the plasma, consisting of electrons, ions, and neutral caesium atoms, as free particles under the influence of their mutual space charge field. A method is outlined by which the potential distributions corresponding to different operating conditions may be calculated completely. In this fashion the operating characteristics of the converter may be related to the self-consistent space charge potentials. Instabilities as possible sources of tube oscillations are briefly discussed.

1912 EXPERIMENTAL INVESTIGATIONS OF THE CESIUM PLASMA CELL.
W.A.Ranken, G.M.Grover and E.W.Salmi.
J. appl. Phys. (USA), Vol. 31, No. 12, 2140-53 (Dec., 1960).

Some aspects of the performance of a caesium plasma cell with tantalum emitter are evaluated in terms of experimental determinations of the effects of variations in such parameters as caesium vapour pressure, emitter temperature, and emitter-collector separation distance. Experiments relating to the effect of collector sex rations and to the feasibility of radiation shielding are described. Voltage-current characteristics are presented for several emitter temperatures and for a wide range of caesium vapour pressure.

1913 THE PRODUCTION OF ELECTRON BEAMS WITH HIGHER ENERGY TRANSPORT.
M.von Ardenne and S.Schiller.
Exper. Tech. der Phys. (Germany), Vol. 8, No. 3, 97-102 (1960). In German.

Describes an apparatus in which, with an accelerating potential of 22.5 kV, an electron beam of 2A with a diameter of 3 mm is produced at a residual gas pressure of about 10^{-4} torr. J.Dutto

1914 NUMERICAL INTEGRATION OF MARGINAL RAYS IN ELECTRON OPTICS. R.Lapeyre and M.Laudet.
C.R. Acad Sci. (France), Vol. 251, No. 6, 863-5 (Aug. 8, 1960). In French.

Extends the previous method (Abstr. 19742 of 1960) of transforming the ray equation into difference form suitable for calculating marginal rays. The method is especially suitable for digital computation and an example is given.

A.E.I. Research Laboratories

1915 DETERMINATION OF ELECTRODE SHAPES FOR AXIALLY SYMMETRIC ELECTRON GUNS. K.J.Harker
J. appl. Phys. (USA), Vol. 31, No. 12, 2165-70 (Dec., 1960).

The determination of the electrode shapes for an electron gun involves solving Laplace's equation subject to specified boundary values of voltage and normal field on an open curve. Past attempts to solve this problem for the case of axial symmetry by mathematical methods have met with considerable difficulties because the problem is improperly set and leads to unstable solutions. Following Garabedian, the problem is reformulated in such a manner that it becomes properly set, and is applied to a curvilinear space-charge limited flow gun. First, a conformal transformation is made which maps the beam boundary into a coordinate axis. The second

ep, which constitutes the essence of the method, is accomplished making an analytic continuation of Laplace's equation and its undary values into a fictious complex domain. Laplace's equation, iich is elliptic in the real domain, is thereby converted into a set hyperbolic equations. This leads to a stable scheme of computa- on by finite differences. This method should find particular appli- tion to curvilinear flow guns, where the use of analogues, such as e electrolytic tank, requires the use of involved experimental chniques. The method is very general, however, being applicable any configuration where the boundary conditions are given through alytic functions. If required, these specifications for the boundary nditions may be given implicitly, as for example, through a set differential equations.

1916 CONSTANT GRADIENT IRON-LESS QUADRUPOLAR LENSES. A.Septier.
uclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 217-18 May, 1960). In French.

1917 QUADRUPOLE LENSES, THE FIELDS OF WHICH DO NOT POSSESS ANTISYMMETRY. A.M.Strashkevich.
h. tekh. Fiz. (USSR), Vol. 30, No. 10, 1199-1206 (Oct., 1960). Russian.

The lateral potential distribution of two asymmetrical electro- tatic quadrupoles is analytically determined. The relativistic quations for the motion of charged particles through these are pplied on the assumption that the potentials do not depend on dis- nce measured along the optical axis of the system. Focal lengths re obtained and compared with those holding for symmetrical uadrupoles. [English translation in: Soviet Physics - Technical hysics (USA)]. A.E.I. Research Laboratory

1918 SPHERICAL ABERRATION OF QUADRUPOLE MAGNETIC LENSES. M.G.Markovich and I.I.Tsukkerman.
h. tekh. Fiz. (USSR), Vol. 30, No. 11, 1362-8 (Nov., 1960). In ussian.

Expressions for the spherical aberration of asymmetrical agnetic quadrupoles are given, special attention being paid to rms of negative sign. It is shown that, by altering the degree of symmetry the relative magnitudes of positive and negative terms an be altered, and it is further claimed that under suitable con- itions, the overall aberration may be made negative. [English anslation in: Soviet Physics–Technical Physics (USA)]. A.E.I. Research Laboratory

1919 THE SPHERICAL CONDENSER AS A HIGH TRANSMISSION PARTICLE SPECTROMETER. I. POINT OURCE. R.H.Ritchie, J.S.Cheka and R.D.Birkhoff.
uclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 157-63 an., 1960).

The inverse square electric field between two concentric harged spheres provides a focusing of charged particles which ave a point source on the inner sphere. An analysis of the trans- ission, resolution, and the line profile shape which may be btained with a spectrometer utilizing this focusing has been rried out analytically and graphically. It is found that the actional transmission This related to the resolution $\delta\frac{1}{2}$ (the actional energy spread at half the maximum transmission) according $T = \sqrt{\delta\frac{1}{2}}$. Transmissions as high as 25% are obtainable at 6% nergy resolution with such a device.

1920 THE DIRECTIONAL DISTRIBUTION IN THE MULTIPLE SCATTERING OF ELECTRONS OF MEDIUM ENERGIES Y THIN CARBON FILMS. R.A.Haefer.
ptik (Germany), Vol. 17, No. 4, 213-27 (April, 1960). In German.

The transmission factor for electrons and their directional istribution during scattering are calculated for thin films of rela- ve mass thickness p in the range 0 to 1, assuming that only simple cattering occurs. The theory is largely confirmed by measuring e transmission factor and scattering distribution of carbon films s functions of p, beam energy and scattering angle. R.Reed

1921 MEASUREMENT OF THE g FACTOR OF FREE, HIGH-ENERGY ELECTRONS.
.A.Schupp, R.W.Pidd and H.R.Crane.
hys. Rev. (USA), Vol. 121, No. 1, 1-17 (Jan. 1, 1961).

For previous work, see Abstr. 5686 of 1954. 100 keV electrons 0.1 μsec bunches were sent into a gold foil. The part of the electron bunch which was scattered at right angles, and which, consequently, was partially polarized, was trapped in a magnetic field and held for a measured length of time (up to 300 μsec). The bunch was then released from the trap and allowed to strike a second gold foil. Counters received the electrons scattered at plus and minus approximately 90°. The cycle was repeated 1000 times per sec. The asymmetry in intensity in the two directions depended upon the final direction of polarization. A plot of the intensity asymmetry versus trapping duration is a cosine curve, whose frequency is the difference between the orbital frequency and the spin precession frequency. This is related to the g-factor as follows: $\omega_D m_0 c/Be = a$, where g is $2(1 + a)$. Thus the "anomaly", a, is measured directly. The determination of B presents some difficulty because the field must be slightly nonuniform in order to trap the electrons. The spatial variation in B from the centre of the trap to the ends is only 0.3%, and the time average of B which applies to the trapped electrons is evaluated to 0.1%. Measurements made at other electron energies, down to 50 keV, showed a slight dependence of a upon energy. The dependence is attributed to electrostatic charges on the surfaces in the trapping region. The final standard error quoted is, however, purposely made large enough so that the variation of a with energy is bracketted. The result is $a = 0.001\,160\,9 \pm 0.000\,002\,4$.

1922 ELECTRON SCATTERING BY THIN FOILS FOR ENERGIES BELOW 10 keV. H.Kanter.
Phys. Rev. (USA), Vol. 121, No. 2, 461-71 (Jan. 15, 1961).

The transmission (η_T) of electrons through thin films of C, Al_2O_3, Al, Ni, Ag, and Au, together with their distribution in angle and energy, were measured in a spherical retarding-potential analyser. The distributions were characterized by average and most probable scattering angle, average and most probable fractional energy loss, etc. The dependence of these variables on initial energy (E_p), film thickness, and material was investigated. For sufficient film thickness, the transmitted energies, the scattering angles and η_T can be represented as universal functions of the reduced energy, E_p/E_c, where E_c is the critical E_p for the onset of transmission. Direct relations exist between η_T, scattering angles, and energy losses for the complete range of scattering from small-angle scattering to total diffusion. The dependence of η_T and average fractional energy loss on Z is consistent with published results on backscattering coefficient and energy loss for thick layers. An estimate of the mean free path for inelastic collisions proves to be in good agreement with the predictions of the Bohr-Bethe theory. Range-energy relations are almost independent of Z when the range is measured in mass per unit area.

ION EMISSION . ION BEAMS

1923 MEASUREMENTS OF FIELD ION CURRENTS. K.Bahadur.
J. sci. industr. Res. (India), Vol. 19B, No. 6, 177-9 (June, 1960).

Accurate measurements of field ion currents in a field ion microscope were made using a specially designed tube in which secondary emission and spurious spatial ionization effects have been eliminated. The results agree with those derived from the theory (Abstr. 5159 of 1956).

1924 MODIFIED DESIGN FOR ION-SOURCE CANALS. K.R.Chapman and G.L.Wrenn.
J. sci. Instrum. (GB), Vol. 38, No. 1, 26-7 (Jan., 1961).

The possibility of replacing the orthodox cylindrical ion-source canal by a series of diaphragms is considered and some advantages of this modification are described.

1925 A THEORY ON OBTAINING SHORT BURSTS OF IONS FROM A BEAM OF IONS. T.K.Fowler and W.M.Good.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 245-52 (June, 1960).

Many modern-day experiments in nuclear physics, particularly neutron physics, require short duration bursts of ions whose definition in energy and angle correspond to an ion beam of rather high quality. This paper treats the problem of producing bursts of ions by beam sweeping across an aperture. By considering several

examples of electric-field sweeping, it is shown that (a) an essential equivalence exists between different time-varying wave forms that may be employed, (b) that the beam quality, as measured by energy and/or angular spread, is necessarily diminished in the process of burst production. In a general way it is shown that if a steady "monoenergetic" beam, characterized by y-component of momentum spread Δp_y and object size Δy, is chopped by beam sweeping, then there is a relation which in its simplest form is given by $\Delta E \Delta t = \Delta p_y \Delta y$. In this relation ΔE is the energy that must be introduced into a monoenergetic beam in order to produce bursts as short as Δt. Finally, it is shown that beam bunching results in diminished beam quality. An example is klystron bunching of a nearly parallel pulsed beam. In this case there is a relation, the simplest form of which is $\Delta E_a \Delta t_a = \Delta E_b \Delta t_b$, relating the product $\Delta E \Delta t$ before bunching to that which exists after bunching.

1926 MAGNETIC QUADRUPOLE LENSES. I. P.Grivet and A.Septier.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 126-56 (Jan., 1960). In French.

The first part discusses the properties of quadrupole lenses. Integration of the equations of motion is possible if the characteristic function of the transverse gradient is represented by simple mathematical models i.e. rectangular or bell shaped models. Formulae of the main elements of a lens and of a system of two crossed lenses are given. The second part is devoted to measures of field and gradient on typical magnetic lenses for CERN's 50 MeV linear proton accelerator, i.e. determination of the various components of field and transverse gradient inside the lens and in the leakage fields, calculation of equivalent lengths relative to the transverse field and to the gradient and correction of the variations of these equivalent lengths in the useful space. Measurements made with very high intensities on saturated lenses show that the poles do not saturate and thus the field configuration is not disturbed. The measuring instruments used are described in detail and results are given in graphical form.

1927 MAGNETIC QUADRUPOLE LENSES. II. P.Grivet and A.Septier.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 243-75 (Feb., 1960). In French.

After recalling the optical properties of quadrupole lenses and showing the results of magnetic measurement giving the field configuration in the spaces crossed by the particles, a method of direct study of optical properties is given and, in particular, of aberrations in a system of two crossed lenses. This is done by means of a special ionic-optical bench. It is shown that the aperture defect can be corrected in a relatively simple way in this type of lens, by correcting the profile of the polar pieces. The last part is devoted to the calculation of the aperture defects by different methods. After giving the equations of motion to the third order, a simple method of calculation is given which is based on representing the characteristic function of the lens by a rectangular model, and which gives fairly good results. The results are then given of calculations made by different electronic machines. These calculated results are very near to the experimental results, but more optimistic.

1928 INSTRUMENTATION PROBLEMS IN FIELD-IONIZATION MASS SPECTROMETRY. H.D.Beckey and D.Schütte.
Z. InstrumKde (Germany), Vol. 68, No. 12, 302-7 (Dec., 1960). In German.

The ionization of molecules by electron impact in mass spectrometers can be replaced by field ionization. Field-emission ion-sources have the disadvantage of large fluctuations in the recorded ion beam. With the usual time constants of recording systems of several tenths of a second, the fluctuations amount to about ±20%. The reasons for these fluctuations are investigated theoretically and experimentally. They can be reduced by ion optical systems which focus a maximum fraction of the ion beam which leaves the emission tip under an angle of about 120^0. An ion source with improved ion optics is described and possibilities for further improvements are discussed.

1929 ATOM EJECTION PATTERNS IN SINGLE-CRYSTAL SPUTTERING. G.S.Anderson and G.K.Wehner.
J. appl. Phys. (USA), Vol. 31, No. 12, 2305-13 (Dec., 1960).

Experimental studies of the atom ejection patterns in single-crystal sputtering mostly by Hg^+ ions have been made. These patterns give evidence of the anisotropic spread of energy from a collision centre, and support the concept of focusing collisions i[n] nearest and next-nearest neighbour directions. In Ge the patter[n] were found to be strikingly similar to those from a b.c.c. crysta[l] This could be explained by assuming that under ion bombardmen[t] so many interstitials are formed near the surface that the atom [ar]rangement of the Ge crystal resembles that of a b.c.c. lattice.

1930 SPUTTERING OF SILICON WITH A^{+2} IONS. S.P. Wolsky and E.J.Zdanuk.
Phys. Rev. (USA), Vol. 121, No. 2, 374-5 (Jan. 15, 1961).

A gravimetric technique involving a sensitive quartz micro-[b]balance was used for the determination of sputtering yields for t[he] argon ion-bombardment of silicon. The sputtering yield for A^{2+} [is] was deduced from the results of experiments in which the relati[ve] concentrations of A^+ and A^{2+} ions were varied in a known manne[r]. On the assumption that sputtering is a kinetic-energy-controlled phenomenon, one would expect $S_E(A^{2+}) = S_{2E}(A^+)$, where S is the number of atoms sputtered by an impinging ion of energy E. Th[e] investigation showed, however, that $S_E(A^{2+}) \cong 4S_{2E}(A^+)$. This indic[ates] the influence in the sputtering process of some other factor in addition to the ion kinetic energy.

PARTICLE ACCELERATORS

ACCELERATOR FOR NEUTRON PRODUCTION. See Abstr. 508

1931 HIGH-VOLTAGE ACCELERATORS. A.Charlesby.
Nature (GB), Vol. 188, 785-6 (Dec. 3, 1960).

Report of a conference held at Amsterdam, 4-6 October, 19[60]. A total of 22 lectures were given. The session on the first day [was] devoted to applications in nuclear physics; the second to the new[er] tandem accelerators and the types of experiments on which these [are] now used. Separate sessions on the morning of the third day wer[e] devoted to varied topics in neutron physics, isotopes separation [and] vation analysis, and solid state research. The concluding sessio[n] the afternoon of the third day outlined contributions in radiobiol[ogy], industrial and medical applications and future accelerators for [high]-power applications.

1932 LOW ENERGY PARTICLE ACCELERATORS FOR PRECISION NUCLEAR PHYSICS RESEARCH. F.L.Niemann.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 338-49 (June, 1960).

The three types of particle accelerators presently available [for] precision research in the nuclear binding energy range are positi[ve] ion linear accelerators, azimuthally-varying-field cyclotrons, an[d] multi-stage Van de Graaff accelerators. The state of developme[nt] of these accelerators is reviewed and their relative advantages [and] disadvantages are compared on the basis of performance capabi[lities], approximate costs and availability.

1933 TECHNIQUES OF CHEMICAL RESEARCH WITH TH[E] ELECTRON VAN DE GRAAFF. C.D.Wagner, V.A.Campanile and V.P.Guinn.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 238-42 (Feb., 1960).

The 3 MeV electron Van de Graaff at Shell Development Co[m]pany is at present used as a source of high energy electrons, hig[h] energy photons, and thermal neutrons, the machine time for acti[vi]ties with these being approximately equal. Kinds of research in[clude] development of radiation-stable petroleum products, exploration [of] new processes based on radiation, basic research in organic rad[ia]tion chemistry, and neutron activation analysis. An account is g[iven] of several phases of the work performed to adapt the accelerato[r] these uses.

1934 MILLIMICROSECOND PULSING — ITS APPLICATI[ON] AND TECHNIQUE. W.M.Good.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 323-30 (March, 1960).

A terminal pulsed Van de Graaff generator is capable of

livering 500 μA and more peak currents in bursts of 2-10 mμsec ne duration at arbitrary repetition rates. It is shown how illimicrosecond intervals of time relative to these bursts can be easured and recorded. Applications of such measurements to clear physics are given. Some of the problems encountered in oducing bursts of ions at the terminal of a Van de Graaff are out- ied by considering the application of a simple sinusoidally varying ltage to obtain bursts. It is shown that existing techniques can be proved substantially in a number of ways.

1935 AN ELECTRON ACCELERATOR IN PRESSURIZED TANK FOR 3 mA AT 1.5 MV DIRECT VOLTAGE.
Henneberke.
clear Instrum. and Methods (Internat.), Vol. 7, No. 1, 89-98 pril, 1960).

A 14-stage accelerating tube is supplied by a 7-stage ockcroft—Walton generator with selenium rectifying units. The tential distribution across the accelerating tube is ensured by a rallel resistor. Special care was devoted to the electron-optical rt and this makes it possible to control a 3 mA electron beam with current of 110 μA through the parallel resistor at a generator load 3.2 mA. Focussing and intensity of the beam are independent of e high tension. X-ray intensities of 300 r/min at a distance of one etre from the target are readily attainable.

1936 A CONVENIENT METHOD OF CONSTRUCTING ACCELERATOR SECTIONS.
.R.Chapman and S.Gowariker.
uclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 215-16 May, 1960).

A method for the construction of focusing and accelerator ections for use with ion sources is described. The advantages of is method are stated and details given of the performance. A poss- ble extension of the application of this technique is described.

1937 THE OAK RIDGE RELATIVISTIC ISOCHRONOUS CYCLOTRON.
ompiled and edited by R.S.Livingston and F.T.Howard.
DEVELOPMENT OF THE ISOCHRONOUS CYCLOTRON.
uclear Instrum. and Methods (Internat.), Vol. 6, No. 1, 1-25 Dec., 1959).

A variable-energy cyclotron of unusual versatility is described. this cyclotron a spatially varying magnetic field provides for oth focusing and isochronous orbits. This azimuthally varying eld has three-fold symmetry and gives an estimated maximum nergy of 75 MeV for protons, 100 MeV for N^{4+}. Flexibility in nergy and choice of particle to be accelerated are achieved with resonant system tunable between 22.5 and 7.5 Mc/s and with l sets of magnet coils which can be adjusted individually to ontrol the magnetic field configuration. Background information n the development of this type of cyclotron is included.

1938 THE OAK RIDGE RELATIVISTIC ISOCHRONOUS CYCLOTRON. II. MAGNETIC FIELD DESIGN FOR HE ISOCHRONOUS CYCLOTRON.
L.Cohen, H.G.Blosser, E.D.Hudson, R.S.Lord and R.S.Bender.
clear Instrum. and Methods (Internat.), Vol. 6, No. 2, 105-25 an., 1960).

The model magnet work and design studies which resulted in e selection of a three-sector azimuthally varying magnetic field th weak spiral are described. A four-sector, tight-spiral was so considered.

1939 THE OAK RIDGE RELATIVISTIC ISOCHRONOUS CYCLOTRON. III. ANALYSIS OF ION ORBITS IN HE ISOCHRONOUS CYCLOTRON. M.M.Gordon and T.A.Welton.
clear Instrum. and Methods (Internat.), Vol. 6, No. 3, 221-33 eb., 1960).

Calculations of radial and axial stability limits in three- and ir-sector azimuthally varying magnetic fields are reviewed. The e of the radial instability at $\nu_r = 1$ to provide a resonance method beam deflection is discussed.

1940 THE OAK RIDGE RELATIVISTIC ISOCHRONOUS CYCLOTRON. ADDENDUM. SOME RECENT RESULTS F ORBIT STUDIES. R.H.Bassel and R.S.Bender.
clear Instrum. and Methods (Internat.), Vol. 6, No. 3, 234-7 eb., 1960).

Analytic expressions developed for the focusing frequencies and other parameters of orbit motion make interpretation of magnetic field data more meaningful and calculations with small-N machines more precise.

1941 ON A DESIGN OF WIDE RANGE MAGNET FOR CYCLOTRON. H.Kumagai.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 213-16 (Jan., 1960).

A design principle of electromagnets is described in which the magnetic induction B in the pole iron is constant. This gives a constant relative distribution of magnetic field in the gap for a wide range of field. Results of applications in two cases are described.

1942 IRRADIATION OF METALS AT CONTROLLED ELEVATED TEMPERATURES IN THE M.I.T. CYCLOTRON. C.E.Ells.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 276-8 (Feb., 1960).

Metals have been irradiated in the M.I.T. cyclotron at controlled temperatures up to 750°C. The construction of the specimen holder and its performance is briefly described.

1943 CYCLOTRON INSTRUMENTATION FOR NUCLEAR REACTION STUDIES BY MAGNETIC ANALYSIS.
B.Sjögren.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 274-88 (June, 1960).

An instrumentation for magnetic analysis work at a small cyclotron (7 MeV deuterons, 14 MeV α-particles) is described. The equipment consists of two quadrupole lenses and an analysing magnet for the preparation of a beam spot on the target and of a magnetic spectrometer for investigation of the reation particles. The magnetic analysers have perpendicular bending planes. Angular distributions can be measured from 0° to 135°. The detectors, the adjustments, the experimental procedure and the performance of the system are discussed.

537.54 : 539.12

1944 ANGULAR DISTRIBUTION AND POLARIZATION OF THE RADIATION EMITTED BY ELECTRONS ACCELERATED IN A SYNCHROTRON.
D.E.Bedo, D.H.Tomboulian and J.A.Rigert.
J. appl. Phys. (USA), Vol. 31, No. 12, 2289-93 (Dec., 1960).

The paper presents evaluations of the angular distribution of the synchrotron radiation for a high-energy accelerator. The investigation indicates that the peak power, at wavelengths in excess of a certain critical value, does not occur in the orbital plane but at some angle above or below this plane. Expressions are given for the intensity components of the radiation polarized at right angles to, and in the plane of the orbit, respectively. The radiation emitted by a monoenergetic electron is, in general, elliptically polarized, the ratio between the major and minor axes depending on the angle ψ between the direction of observation and the orbital plane. For $\psi = 0$ the radiation is linearly polarized, and approaches circular polarization with increasing values of ψ.

1945 EXTRACTION OF PROTONS FROM THE BIRMINGHAM 1000 MeV SYNCHROTRON.
G.A.Doran, E.A.Finlay, H.R.Shaylor and M.M.Winn.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 225-36 (June, 1960).

An electromagnetic deflecting channel for protons is described. This is moved close to the circulating beam in the synchrotron vacuum box after the accelerating cycle has commenced. Protons are induced to enter the deflector by Coulomb scattering through a very small angle, and when the current flowing through the deflector is ~ 35 kA the protons are deflected through an angle ~ 0.03 radians and escape from the synchrotron. The number of protons available per pulse in the experimental area has been increased by a factor ~ 1000 from that obtained previously by nuclear scattering from internal targets.

1946 DEPOLARIZATION OF A BEAM OF POLARIZED PROTONS IN A SYNCHROTRON.
M.Froissart and R.Stora.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 297-305 (June, 1960). In French.

An initially polarized proton beam, when injected in a synchro-

tron, may suffer substantial depolarization effects, in view of magnetic field inhomogeneities "seen" by individual particles within the beam. A semiquantitative study is made for the 3 GeV Saclay synchrocylotron. There, the combined effect of vertical betatron oscillations and passage through the straight sections fringing fields is critical. One finds indeed that a certain resonance condition is fulfilled for two values of the energy within the acceleration cycle, which entails a large depolarization in the present case. On the other hand, perturbations due to magnetic inhomogeneities inside the quadrants and the accelerating cavity as well as effects due to synchrotron oscillations prove to be small. It is felt that the analysis presented here could be extended to other machines and other types of accelerated particles. In particular, it is easy to see whether the resonance condition implies the existence of "dangerous" energy regions or not.

1947 A MODULATOR FOR THE BONN SYNCHROCYCLOTRON USING FERROELECTRIC CERAMIC.
H.Brückmann.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 169-75 (Jan., 1960). In German.

The frequency modulation system for the university of Bonn 190 cm synchrocyclotron is described. The unusual feature of this system is the use of Ba-Sr-TiO_3 sinterceramic capacitors for the variable capacity. 4.3% frequency modulation is obtained at 11 Mc/s with 24 capacitors (0.6 mm thick and 11 mm dia., mounted in xylene) each controlled by a low frequency modulating voltage up to 1400 V. Design problems, concerning heat transfer and breakdown are discussed. The main advantage of this system is that many modulating wave-shapes and repetition rates are possible.

1948 DESIGN, CONSTRUCTION AND TESTING OF A MICROTRON. H.Reich.
Z. angew. Phys. (Germany), Vol. 12, No. 11, 481-93 (Nov., 1960). In German.

Relates to a 5 MeV machine which was built to investigate the possibility of realizing much higher energy accelerators based on the microtron principle. A brief discussion of the basic theory is followed by an account of the principal design and constructional features. The wavelength is 10.7 cm, and the magnetic field 1000 G. Relying on field emission from the lips of the cavity, a peak current of 200 μA was attained. Using a Ta cathode within the cavity, and exposed to the h.f. field, the current was raised to 500 μA. A major difficulty in extending the principle to higher energies is seen in the need for increasingly tight tolerances on the magnetic field, this leading to a ceiling in the neighbourhood of 20 MeV. E.A.Ash

1949 THEORY OF THE MOTION OF PARTICLES IN AN ACCELERATOR WITH VARIABLE "PERIODICITY" [KRATNOST'YU] — THE MICROTRON. A.A.Kolomenskii.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 11, 1347-54 (Nov., 1960). In Russian.

In the microtron, particles describe circular paths, being accelerated by an alternating electric field once in each revolution. It is arranged that the times taken to describe successive circles differ by a multiple of the frequency of the accelerating field. The variations in phase of the accelerated particles are expressed in the form of finite difference equations and illustrated by phase diagrams. [English translation in: Soviet Physics–Technical Physics (USA)].
A.E.I. Research Laboratory

X-RAY TUBES AND TECHNIQUES

1950 EXPERIMENTS IN X-RAY PHYSICS USING A COMMERCIAL X-RAY SPECTROMETER. L.Muldawer.
Amer. J. Phys., Vol. 28, No. 9, 811-13 (Dec., 1960).

Such instruments can be used in simple analysis experiments but can also be used for additional experiments in X-ray physics. The tungsten L spectrum and the general shape of the continuous spectrum can be observed by scattering from elements of low atomic number. Absorption edges can readily be shown and the quantum limit of the continuous spectrum can be seen to vary with tube voltage. Planck's constant can be determined. Monochromatic X-ray beams can be obtained and utilized in the measurement of absorption coefficients.

1951 THE CANADIAN STANDARD FREE-AIR CHAMBER F MEDIUM QUALITY X-RAYS. W.H.Henry and C.Garr
Canad. J. Phys., Vol. 38, No. 12, 1677-89 (Dec., 1960).

A description is given of the Canadian standard free-air chan ber for measurement of medium quality X-rays, including measur ments of the contribution from radiation scattered from the air and from the diaphragm, and a method for the accurate alignment of the chamber and X-ray source.

1952 ROTATING X-RAY TUBE FOR VACUUM SPECTROGRAPH. V.A.Trapeznikov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 639-40 (April, 1960). In Russian.

A description of an improved design of an X-ray tube rotating on a bearing, mounted in the lid of the vacuum spectrograph, and driven directly by a sine mechanism. M.H.Slobo

1953 PHOTOMULTIPLIER SOFT X-RAY SPECTROMETER. L.Jacob, R.Noble and H.Yee.
J. sci. Instrum. (GB), Vol. 37, No. 12, 460-3 (Dec., 1960).

The spectrometer uses a Be—Cu photomultiplier as detector. Unlike most spectrometers of this type it is not a modification of previously existing photographic instrument, but was designed specifically to take advantage of the new technique. In particular, the photo-detector is made to move around the Rowland circle by the simple expedient of mounting it on a radial arm. Its method o use is described and the emission band spectra of Al, Mg, Na and are given as examples of results obtained with it.

1954 RIGHT-ANGLE SCATTER FOR X-RAY BEAMS OF 0.14 mm TO 2.5 mm COPPER H.V.L.
A.P.Sanders, C.W.Chin, K.W.Sharpe, R.J.Reeves and G.J.Baylin.
Radiology (USA), Vol. 75, No. 4, 595-8 (Oct., 1960).

Right-angle scatter coefficients were determined as a functio of half-value layer (from 0.14 to 2.5 mm Cu), of area of field, and of perpendicular distance from the central beam axis.

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

1955 THE MAGNETIZATION AND FIELD OF CYLINDRICA BODIES. G.Obermair and C.Schwink.
Z. Phys. (Germany), Vol. 160, No. 3, 268-76 (1960). In German.

The effective field is calculated in terms of series expansion whose coefficients may be determined from the deflection of an electron beam under the influence of this field. E.P.Wohlfa

1956 THE STABILITY OF AN ASTATIC SYSTEM; THE INFLUENCE OF THE VALUE OF THE MAGNETIC MOMENT. Ş.Pătraşcu.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 1, 173-6 (1959). In Roumanian.

The stability of an astatic instrument to stray fields is impr ved if the magnets used have a high magnetic moment.
E.P.Wohlfa

PROTON PRECESSION MAGNETOMETER IN GEOPHYSICA MEASUREMENTS: ACCURACY. See Abstr. 1576

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

1957 ON THE DRIFT VELOCITY OF CHARGED PARTICL IN A MAGNETIC DIPOLE FIELD. M.Siebert.
Naturwissenschaften (Germany), Vol. 47, No. 15, 351 (1960). In German.

Points out that an accepted formula for the drift velocity of charged particle spiralling round a field line in a magnetic dipol may be in error. This expression contains two terms, one arisi

n the curvature of the field lines and the other from the centri-
al force in a circular orbit. A closer analysis shows that a third
n connected with extra centrifugal force arising from the curva-
e of the field lines cannot be neglected.

A.E.I. Research Laboratory

1958 ELECTRODYNAMICS OF A CHARGED PARTICLE MOVING THROUGH A PLASMA WITHOUT MAGNETIC
ELD. S.K.Majumdar.
oc. Phys. Soc. (GB), Vol. 76, Pt 5, 857-69 (Nov., 1960).

The motion of a charged particle through a low density electron
sma was investigated using equation of momentum transfer in a
sma and Maxwell's equations for electromagnetic field. It was
wn that, for a particle velocity greater than the average thermal
ocity of the plasma electrons, a Cherenkov-like effect is set
in the plasma, only in the case of longitudinal wave motion. The
stence of Mach cone was derived and the nature of the energy
s investigated.

1959 THE MAGNETOGRAVITATIONAL INSTABILITY OF AN INFINITE HOMOGENEOUS MEDIUM WHEN A CORIOLIS
RCE IS ACTING AND VISCOSITY IS TAKEN INTO ACCOUNT.
G.Pacholczyk and J.S.Stodołkiewicz.
l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7,
7, 429-34 (1959).

It is shown that the critical wavelength of a perturbation is not
arged by the presence of viscosity. R.A.Newing

1960 THE MAGNETOGRAVITATIONAL INSTABILITY OF A MEDIUM IN NON-UNIFORM ROTATION.
G.Pacholcyzk and J.S.Stodółkiewicz.
l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7,
8, 503-7 (1959).

The problem of stability with respect to axially symmetric
turbations is considered for an isothermal non-viscous medium
infinite electrical conductivity in the presence of a magnetic
ld, the lines of force being circles centred on the axis of sym-
try. It is suggested that the spiral arms of the galaxy may have
sen from instability. An investigation of the stabilizing effect of
magnetic field, together with the observed dimensions of the
ral arms, is used to derive an upper limit to the magnetic field
a model proto-galaxy. R.A.Newing

1961 THE MAGNETOGRAVITATIONAL INSTABILITY OF THE MEDIUM OF FINITE ELECTRICAL CONDUCT-
TY. A.G.Pacholczyk and J.S.Stodółkiewicz.
l. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7,
11, 681-5 (1959).

It is shown that the criterion for the gravitational instability of
otating non-viscous medium of finite electrical conductivity is
affected by the magnetic field independently of the existence of a
d component parallel to the direction of propagation of the per-
bation. R.A.Newing

1962 ON THE STABILITY OF A GRAVITATING LIQUID CYLINDER CARRYING A NON-UNIFORM VOLUME
RRENT AND SURFACE CHARGE. B.B.Chakraborty.
Astrophys. (Germany), Vol. 51, No. 2, 107-18 (1961).

The stability is studied of an ideally conducting, gravitating and
nite liquid cylinder carrying a volume current along the axial
ection which is proportional to r^n, where r is the distance from
axis of the point under consideration. The disturbances are
en as axisymmetric. For each axial wave number, there exist
table disturbances whatever the value of n.

1963 THE STABILITY OF A CURRENT-CARRYING FLUID CYLINDER IN THE CASE OF FINITE CONDUCTIVITY.
Breus.
tekh. Fiz. (USSR), Vol. 30, No. 9, 1030-4 (Sept., 1960).
ussian.

The stability of a fluid cylinder carrying a uniform current in
presence of a longitudinal magnetic field is investigated. For
conductivity, the system is unstable both at very long and at very
t wavelengths, whatever the magnitude of the longitudinal field.
high, but not infinite, conductivity the system is unstable against
urbations with the same helical symmetry as the lines of force
e surface of the cylinder. [English translation in: Soviet
sics–Technical Physics (USA)]. O.Penrose

1964 ON THE FLOW OF A CONDUCTING LIQUID THROUGH A DIAPHRAGM, IN THE PRESENCE OF A MAGNETIC
FIELD. E.Crausse and Y.Poirier.
C.R. Acad. Sci. (France), Vol. 250, No. 22, 3573-5 (May 30, 1960).
In French.

An expression is derived for the loss of charge when the liquid
flows through a circular hole in a thin diaphragm. This is the sum
of two terms; the first is proportional to the speed of flow and
depends upon the magnetic induction, while the second is proportional
to the square of the speed and is independent of the magnetic
induction. A.H.Gabriel

1965 EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF AN ELECTROMAGNETIC FIELD ON
THE FLOW [OF A LIQUID] PAST A CYLINDER. I.A.Kuznetsov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1041-5 (Sept., 1960).
In Russian.

The solution of an electrolyte is flowing past a copper cylinder.
An electric current is maintained in the liquid in direction trans-
verse to the flow. By means of an electromagnet a vertical magnetic
field is maintained. The resulting force on the liquid acts either
parallel or antiparallel to the direction of flow. In order to obtain
evidence for the effect of this force on the pattern of flow, the dis-
tribution of velocity is measured over the cross-section of the con-
tainer in the wake of the cylinder. It is found that the velocity of the
liquid is markedly increased by the parallel force and even more
reduced by the antiparallel force. [English translation in: Soviet
Physics–Technical Physics (USA)]. R.Eisenschitz

1966 MASS TRANSPORT IN LIQUID METALS PERPENDICULARLY TO CROSSED ELECTRIC AND MAGNETIC
FIELDS. H.Knof.
Z. Naturforsch. (Germany), Vol. 15a, No. 8, 745-6 (Aug., 1960). In
German.

A motion, perpendicular to both fields, of metal atoms dissolved
in a liquid metal (mercury) can be foreseen theoretically, and was
detected experimentally by passing for six days a current of 15 A,
in a field of 5500 gauss, in an amalgam of 0.1% gold. A marked
gradient of the gold concentration was produced. The correspon-
ding drift velocity of the Au atoms was 0.022 cm/hour.

L.Pincherle

1967 WAVES IN A CONDUCTING SHEET SITUATED IN A STRONG MAGNETIC FIELD. I.C.Percival.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 329-36 (Sept., 1960).

The hydromagnetic approximation is applied to the elementary
linear theory of transverse waves in a thin uniform plane conduct-
ing sheet, in which the inertia is provided by the sheet, and the re-
storing forces by strong vacuum magnetic fields on either side of
the sheet. The dispersion relation and damping are obtained. The
waves should be observable in the laboratory.

1968 MAGNETOHYDRODYNAMIC WAVES IN WAVEGUIDES. J.Szabó.
Z. Phys. (Germany), Vol. 160, No. 5, 491-3 (1960). In German.

A simplified derivation of some of Gajewski's results (Abstr.
1200 of 1960) concerning wave propagation in a perfectly conducting
nonviscous fluid in the presence of a uniform magnetic field applied
parallel to the walls of the containing cylinder. R.A.Newing

1969 MAGNETOHYDRODYNAMIC WAVES WITH FINITE AMPLITUDES. N.V.Saltanov and V.S.Tkalich.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 10, 1253-5 (Oct., 1960).
In Russian.

Considers one-dimensional (cartesian or cylindrical) case and
obtains equations for the transverse components of the magnetic
field and velocity in a conducting fluid, in the presence of a steady
magnetic field. The fields are expressed in terms of two waves
moving in opposite directions (Alfven's waves). [English translation
in: Soviet Physics–Technical Physics (USA)]. J.K.Skwirzynski

1970 MAGNETIC FIELD INTERACTIONS WITH SHOCK-IONIZED ARGON. H.J.Pain and P.R.Smy.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 849-56 (Dec. 1, 1960).

Describes the construction, instrumentation and calibration of
a pressure-driven shock tube. Reports experiments on interactions
occurring between a magnetic field and ionized argon moving at
shock Mach numbers 8 to 23. The conditions for these interactions
were shown to be well defined in terms of the Lundquist and magnetic
Reynolds numbers. The modifications to the fluid flow which resulted

from these interactions were discussed in terms of magnetic body forces on the fluid and steady-state flow patterns associated with different magnetic field configurations were photographed. These showed that a radially symmetric magnetic field could act as a nozzle to plasma flow, that an asymmetric field could shear the plasma flow and that when the interaction was strong enough a reflected shock wave was produced in the plasma.

1971 MAGNETOHYDRODYNAMIC SHOCK WAVES IN A GAS MIXTURE. K.P.Chopra and I.J.Singh.
Z. Phys. (Germany), Vol. 160, No. 4, 431-7 (1960).

The properties are studied of the non-relativistic propagation of a plane shock wave in a gas mixture of charged particles in the presence of an external uniform magnetic field, oriented in a direction transverse to the direction of propagation. Expressions for the pressure, density and velocity ratios are obtained. It is shown that the presence of a transverse magnetic field narrows down the range of values of the density ratio.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

1972 INSTABILITY OF A SYSTEM OF EXCITED OSCILLATORS WITH RESPECT TO ELECTROMAGNETIC PERTURBATIONS. A.V.Gaponov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 326-31 (Aug., 1960). In Russian.

Possible mechanisms for autophasing excited oscillators in a radiation field, leading to instability of the system with respect to electromagnetic disturbances, are considered. It is shown that from the quantum point of view, the instability of such systems may be due to unequal spacing of the (anharmonic) oscillator spectrum or to recoil during the emission of a photon. [English translation in: Soviet Physics - JETP (USA), Vol. 12, No. 2, 232-6 (Feb., 1961)].

1973 THEORETICAL AND EXPERIMENTAL STUDY OF THE BACKSCATTERING CROSS SECTION OF AN INFINITE RIBBON. M.S.Macrakis.
J. appl. Phys. (USA), Vol. 31, No. 12, 2261-6 (Dec., 1960).

The geometrical optics approximation for the backscattering cross section per unit length of an infinite ribbon is derived and compared with the exact theory, the approximate theory of Sommerfeld, the variational method, and with experimental results obtained through the space-separation method for the measurement of backscattering cross sections in a parallel-plate region.

1974 FIELDS IN GAP-EXCITED CIRCULAR DUCTS. J.A.Dattilo and C.Van Bladel.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 283-5 (Feb., 1960).

Formulae for the electric and magnetic fields in a circular waveguide, cut in two by a plane perpendicular to the axis, are given together with some numerical data. The field is excited by a voltage applied across the two halves of duct. The energy and momentum kicks which particles experience upon crossing of the gap are examined is some detail.

1975 THE FADING OF RADIO WAVES REFLECTED OBLIQUELY FROM METEOR TRAILS. G.S.Kent.
J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 272-83 (Dec., 1960).

A study has been made of bursts of signal received at Cambridge over a distance of 500 km from the 53.25 Mc/s B.B.C. television transmitter at Kirk o' Shotts. These signal bursts, believed to be due to reflections from meteor trails, were found to fade at a rate of several cycles per second This fading is believed to be due to changes in the diffraction pattern formed on the ground by waves scattered from separate parts of a meteor trail. By observing the signal bursts on two aerials spaced 200 m apart deductions have been made about the size of the structure in the diffraction pattern and the way in which it changes with time. It is concluded that the scale of the diffraction pattern is determined by the total length of the meteor trail rather than by the size of the individual irregularities into which it breaks and the value found for the mean trail length is in good agreement with that found by other workers. The fading is found to be due to two causes, to random movments inside the trail and to rotation of the trail as a unit under the action of a wind shear. Values deduced for the r.m.s. random velocity and for the wind shear are again in agreement with those believed to exist in the E-region.

1976 RECORDING TYPE DIRECTION FINDER. K.Miya and S.Matsushita.
Rep. Ionosphere Space Res. Japan, Vol. 13, No. 2, 120-2 (June, 195

The direct vision type direction finder described in Abstr. 5828 B of 1960; Rep. Ionosphere Res. Japan, Vol. 11, No. 1, 1-10 (March, 1957) has been adapted to study the characteristics of radio waves propagated via the ionosphere. A recording device has been added by means of which the bearing of the received wave is displayed directly on a pen recorder. D.M.Schla

SUDDEN COMMENCEMENT IONOSPHERIC DISTURBANCES AND THE PROPAGATION OF LONG WAVES. See Abstr. 1542

Radiofrequency Spectroscopy Techniques

1977 NUCLEAR MAGNETIC RESONANCE PULSE APPARAT T.Hashi, A.Hirai, M.Sasaki and T.Kawai.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 205-12 (Sept., 1959).

A detailed description is given of an apparatus intended for measuring proton spin–lattice relaxation times between 10 and 1000 msec in high polymers.

1978 DOUBLE PROTON MAGNETIC RESONANCE BY A SID BAND METHOD. J.Itoh and S.Sato.
J. Phys. Soc. Japan, Vol. 14, No. 6, 851-2 (June, 1959).

The method may be used to measure the difference of two chemical shifts of proton resonances. One of the resonances is strongly saturated and the applied magnetic field is modulated at the difference frequency of the two lines. If the saturation is stro enough, any spin–spin interaction structure will be smeared out and provided that the modulation frequency is exactly right, only o line will be observed, otherwise two lines are observed. J.M.Bak

1979 FIELD HOMOGENIZING IRON PLATES FOR NUCLEA SPIN RESONANCE SPECTROMETER. K.Antonowicz
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 2, 115-16 (1960).

The use of a magnetic filter consisting of two symmetrically disposed soft-iron plates in the magnet gap is shown to increase considerably the field homogeneity. The effectiveness of the filter was shown by observation of the methyl alcohol n.m.r. spectrum. Without the filter a sample of 0.1 cm^3 yielded a simple triplet, the field homogeneity being 1 part in 10^6; with the addition of the filter the lines of the CH_3 and CH_2 groups were split into a triplet and a quadruplet showing the homogeneity to be increased by abou 10 times. S.A.Ahe

1980 SENSITIVITY OF MICROWAVE SPECTROMETERS USING MASER TECHNIQUES. C.H.Townes.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 428-30 (Nov. 1, 1960).

Ways are indicated in which maser-like techniques can great increase the ultimate sensitivity of a microwave spectrometer, in addition to any increase obtained by lowering the effective noise-temperature of the amplifying system. When molecules in a suita excited state are selectively enriched along a waveguide cell, the minimum detectable absorption coefficient is decreased through t modification of the term for the absorption per unit length by a factor proportional to the square root of the difference in proba-bility of absorption and stimulated emission. A similar improve-ment is predicted also when excited molecules are selectively enriched in a cavity spectrometer. An expression is derived for the minimum detectable number of absorbing molecules, which is independent of the matrix element for the absorption. Some condi tions allow detection of only a few molecules. The time required for detection does depend on the matrix element for the absorption

if this is about 10^{-18} e.s.u. the time required is reasonably rt. Such effects gave rise to the increased sensitivity of the ser spectrometer used by Shimoda and Wang (Abstr. 1082 of 1956) example of one practical arrangement utilizing such effects is ined. J.Sheridan

1981 DETECTORS FOR MICROWAVE SPECTROMETERS. M.W.Long.
. sci. Instrum. (USA), Vol. 31, No. 12, 1286-9 (Dec., 1960).
The sensitivity of detectors used in sample modulated microwave spectrometers is investigated. Characteristics of crystal diodes and barretters as functions of microwave power are compared with an ideal detector operating at room temperature. A spectrograph is described which was used to measure a $CFCl_3$ line having a calculated absorption coefficient of 3.9×10^{-11} cm^{-1}. The relationship between recorder deflection and absorption coefficient is discussed.

NUCLEAR PHYSICS

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

1982 SCINTILLATION COUNTERS IN ROCKETS AND SATELLITES. C.E.McIlwain.
Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 159-64 (July-t., 1960). [Proceedings of the Seventh Scintillation Counter nposium, Washington, February, 1960].
The known and conjectured particle populations in space are iewed. The role of scintillation counters in obtaining the present wledge and their possible use in extending this knowledge are cussed. The detectors used in Explorer IV (1958ϵ) and an auroral ket instrumentation are described in detail.

1983 NEW CERIUM ACTIVATED SCINTILLATING GLASSES. R.J.Ginther.
Trans. nuclear Sci. (USA), Vol. NS-7, No. 2-3, 22-31 (June-t., 1960). [Proceeding of the Seventh Scintillation Counter nposium, Washington, February 1, 1960].
Two new types of Ce-activated glass have been developed. One hese, a magnesium aluminium borate, is similar to the alkali ate glasses reported previously (Abstr. 4473 of 1959) and was de in an effort to provide a scintillating glass with the highest sible boron content in which a reasonable pulse height could be ained. Its pulse height with gamma excitation is 5.0% of a NaI(Tl) stal. The second glass developed is a lithium magnesium minium silicate. This glass has a pulse height 14.0% of the (Tl) crystal and is the most efficient material prepared in this gramme. Preliminary studies indicate that energy transfer ween the base glass and the activator does occur, and that the ciency of glass scintillators is not limited by the absence of rgy transfer.

1984 LIGHT COLLECTION IN LIQUID SCINTILLATION CELLS. D.O.Cummins, C.F.G.Delaney and I.R.McAulay.
Proc. Roy. Dublin Soc. A (Ireland), Vol. 1, No. 2, 21-6 (March 1960).
A study was made of light collection in the glass cells used in id scintillation counting. The variation of efficiency of collection r the volume of the cell was investigated for three types of — plain glass, glass with an aluminium foil reflector, and s with a titanium dioxide diffuse reflector. An interesting region pproximately constant efficiency was found in the case of the n glass cell: its possible importance in pulse height analysis iscussed.

1985 THE SEPARATING OF PARTICLES ACCORDING TO THEIR IONIZATION VALUE IN SEVERAL NTILLATION COUNTERS.
K.Akimov, V.I.Komarov, O.V.Savchenko and L.M.Soroko.
lear Instrum. and Methods (Internat.), Vol. 7, No. 1, 37-44 il, 1960).
A telescope of scintillation counters is described by means of h it is possible to register rare processes of particle emission high ionization and small range against a background of outside ation with smaller ionization. Both normal plastic scintillators n thick and filmlike scintillators 0.5 mm thick on a polystyrol with the addition of 1% of tetraphenylbutadiene were used in the counters. The counting responses of the telescope are given for the separation of deuterons from protons with the impulse p = 900 MeV/c, He^3 nuclei from deuterons with the impulse p = 730 MeV/c, and also for α-particles with the energy 800 MeV. The apparatus here described has been used in experiments to investigate the processes: $p + d \rightarrow \pi^+ + H^3$, $d + d \rightarrow He^3 + n$, $d + d \rightarrow \pi^0 + He^4$.

1986 COUNTING EFFICIENCY OF THIN CdS CRYSTALS USED AS CHANNEL CONDUCTORS.
M.Marinov and H.Vodeničarov.
C.R. Acad. Bulg. Sci., Vol. 12, No. 6, 509-11 (Nov.-Dec., 1959). In French.
A crystal counter in which the ionizing particle passes from one electrode to the other, creating a conducting channel, does not suffer from polarization effects. Five such CdS counters were made, and their counting properties studied using a polonium source 0.3 mm diameter. All five crystals had the same counting efficiency, and all were uniform across their area. C.Hilsum

1987 UNSCRAMBLING SCINTILLATION SPECTROMETER DATA. W.R. Burrus.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 102-11 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].
The pulse-height distribution from a scintillation spectrometer may differ considerably from the spectrum of the incident radiation because the radiation may interact in several different ways with the crystal. Statistical variations in the pulses produce an additional distortion. These facts greatly complicate the quantitative analysis of continuous spectra or discrete spectra with more than a few different energies. Although it is not possible to calculate the exact "unscrambled spectrum", it is possible to obtain a "best estimate" of the incident spectrum and to assign meaningful errors to the result. A clarifying point of view based on Fourier techniques is introduced. Methods for numerical calculation are then described.

1988 SCINTILLATION COUNTER γ-SPECTRA UNFOLDING CODE FOR THE IBM-650 COMPUTER.
H.I.West, Jr and B.Johnston.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 111-15 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].
An I.B.M.-650 computer code for the detailed unfolding of γ-ray spectra obtained from NaI scintillation counters has been developed. The procedure is set up to remove analyser scale dependence and to remove energy dependences to a great extent. Computer time is about 1 min. per γ-ray.

1989 COLLECTION TIMES OF LIGHT FROM A CHERENKOV DETECTOR WITH DIFFUSING WALLS.
J.P.Patry, J.Seguinot and M.Scherer.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 2012-14 (Nov. 7, 1960). In French.
The collection times of the light from a Cherenkov detector in the form of a tank with diffusing walls containing distilled water, were compared with the values of these times obtained with the same detector having reflecting walls. Coincidences were measured between high energy cosmic particles penetrating a plastic scintillator, and the pulses from the Cherenkov counter. It was found that the amplitude of the light collection time spread was from 12 to 33 mμsec for the reflecting walls and from 4 to 23 mμsec for the diffusing walls with a marked efficiency loss in the latter case. I.C.Demetsopoullos

1990 A 4π-FISSION DETECTOR. A.Deruytter.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 145-52 (May, 1960).

A technique has been developed to prepare fission foils of uniform thickness on thin plastic films (VYNS-3) coated with Al, to be used as a cathode inside a 4π chamber. The optimum thickness of the Al-coating is 2.5 $\mu g/cm^2$ on both sides of the film. These films are brought in an ionization chamber filled with a mixture of 98% A and 2% N_2. The influence of the thickness of the U^{235} film on the discrimination between fission and alpha pulses has been studied. The evaluated efficiency of the counter for a 1 mg/cm^2 $U^{235}O_2$ foil is (92 ± 1) %; for a 0.1 mg/cm^2 foil (97.5 ± 0.3)%.

1991 HIGH RESOLUTION SPECTROSCOPY USING P–N JUNCTIONS APPLIED TO THE STUDY OF NUCLEAR REACTIONS: THE $O^{18}(d, \alpha)N^{16}$ REACTION.
G.Amsel and O.Smulkowski.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 950-2 (Aug. 17, 1960). In French.

Problems set by the use of silicon p–n junctions as detectors for particles produced from nuclear reactions are considered. A system for the protection of the junction against secondary ions produced by the beam is described. This method of α-ray spectroscopy was used to study the reactions $O^{18}(d, \alpha)N^{16}$ and $O^{16}(d, \alpha)N^{14}$ and α groups of 70 keV separation could be resolved.
A.E.I. Research Laboratory

1992 EXPERIENCE AT HARWELL WITH SURFACE-BARRIER DETECTORS. G.Dearnaley.
IRE Trans nuclear Sci. (USA), Vol. NS-8, No. 1, 11-16 (Jan., 1961). [Proceedings of the Seventh Annual National Meeting. Solid State Radiation Detectors].

Technique for the construction of surface barrier detectors in silicon and germanium is described. Results are presented on their characteristics, sensitive depth, working life, and damage by radiation. Various structures of detector were investigated, and their applications to nuclear physics are discussed.

1993 USES OF SEMICONDUCTOR DETECTORS IN HEALTH-PHYSICS MONITORING. A.R.Jones.
Nucleonics (USA), Vol. 18, No. 10, 86, 88, 90, 91 (Oct., 1960).

Review of experiments in progress at Atomic Energy of Canada Ltd., Chalk River. Alpha and neutron monitors have been successfully built. β and γ monitors require further development owing to the lower amount of ionization produced in the thickest depletion layers available. R.D.Smith

1994 NEW THERMOLUMINESCENT DOSIMETER. J.H.Schulman, F.H.Attix, E.J.West and R.J.Ginther.
Rev. sci. Instrum (USA), Vol. 31, No. 12, 1263-9 (Dec., 1960).

A simple dosimeter design is described in which a thermoluminescent phosphor is mounted on an electrically heatable support in an evacuated or gas-filled envelope. With CaF_2:Mn as the phosphor, the device detects gamma-ray doses in the milliroentgen range and is linear in response up to at least 2×10^5 r. Dose readings can be made in less than a minute with simple instrumentation requiring no darkroom facilities. The dosimeter may be reused many times. The response is independent of dose rate at least over the range 10 mr/min to 7000 r/min. With suitable tin shields the response is independent of energy over the range 40 keV to 1.25 MeV. The advantages of this device for monitoring of personnel in health physics operations are pointed out.

1995 COMBINATION OF MAGNETIC ANALYZERS IN NUCLEAR REACTION EXPERIMENTS. B.Sjögren.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 76-88 (April, 1960).

Different ways to increase the counting rate in measurements with magnetic analysing systems are investigated. It is assumed that a good energy resolution is desirable and that the energy spread of the beam from the accelerator is fairly large (cyclotron). The effect of combining the analysers suitably, as well as the influence of the type and the setting of the target are discussed. Two types of systems are considered, namely analysers with coincident and with perpendicular bending planes. In both of these cases the energy spread caused by the finite opening angle of the second analyser is treated, being of importance for reactions with light nuclei. It is found that it should be possible to use a quite large target spot and thick target layer if the measurement is arranged in the proper way. The following circumstances are then important: the dimensions of the system and type of reaction, the bending direction and field gradient of the second analyser, the target orientation and density and the detector position. The calculations are illustrated by some numerical examples.

1996 MULTI-PURPOSE MAGNETIC PARTICLE ANALYZER. R.L.Burman and A.I.Yavin.
Nuclear Instrum.and Methods (Internat.), Vol. 7, No. 2, 101-12 (May, 1960).

A flexible magnetic particle analyser is proposed. It will be used as (1) a broad range spectrograph; (2) a high intensity spectrometer; and (3) a high resolution spectrometer free of kinematic broadening effects.

Track Visualization

1997 PRODUCTION AND STUDY OF THE PROPERTIES OF NUCLEAR TRACK EMULSIONS.
J.Fournaux, J.Demers and P.Demers.
Canad. J. Phys., Vol. 38, No. 11, 1482-1509 (Nov., 1960). In Fren

Reports systematic experiments on the production of nuclear emulsions based on Demers' formula, using double jet, pure bromo regular agitation and 82% of silver bromide in the dry emulsion. number of tables show the variations of background, grain size, an grain density for tracks of alpha particles, protons, slow and fast electrons, with several factors — chemical equivalence, presence of chloride, demineralization of the gelatine, speed of agitation an flow, triethylamine, and the temperatures and times for the vario stages of the process. Details are given of all the parameters for reproducible emulsions with electron tracks of 25–45 grains per 100 μ. Fission tracks have been obtained which show the origin o the two opposite tracks. Grain sizes are about 0.1 μ. Perfilov's criterion of exact chemical equivalence throughout precipitation is confirmed, and the need for very regular crystals with the minim of defects is stressed. E.J.Bu

1998 INVESTIGATION OF THE SENSITIVITY OF NUCLEA EMULSIONS AT THE TEMPERATURES OF LIQUID NITROGEN AND LIQUID HELIUM. L.Avan and C.Dubois.
C.R. Acad. Sci. (France), Vol. 251, No. 13, 1280-2 (Sept. 26, 1960 In French.

At these temperatures, emulsions K_0 and C_2 were insensitive α-particles, K_5 and G_5 gave continuous tracks at nitrogen tempera tures and, respectively, very faint and about three times minimu ionization at helium temperatures, the G_8 emulsion recording electrons with grain counts about 0.75 of those at ambient temper tures. There are 13 photographs of tracks. E.J.Bu

1999 PRODUCTION OF A PARTICLE TRACK EMULSION IN THE PRESENCE OF AN EXCESS OF Ag^+ IONS.
F.Simon.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1774-6 (Oct. 24, 1960) In French.

Gives details of the method with careful control of the concentration of Ag^+ ions and sensitization by triethylamine.
E.J.Bu

2000 AUTOMATIC SILVER CONCENTRATION CONTROL FOR NUCLEAR EMULSION FIXING BATHS.
E.Dahl-Jensen.
J. sci. Instrum.(G.B.),Vol. 37, No. 9, 360-2 (Sept., 1960).

The potential between a silver electrode and a calomel electr in the "hypo" bath was used to determine the silver concentration A circuit for automatic control is described. E.J.Bu

2001 THE EFFECT OF PROCESSING ON THE TRANSVER DIMENSION OF HEAVY-ION TRACKS IN NUCLEAR EMULSIONS. C.Gegauff and J.P.Lonchamp.
Nuovo Cimento (Italy),Vol. 16, No. 3, 520-31 (May 1, 1960). In French.

Several developers were used with G5, C2 and L4 emulsions containing tracks of He, C, N, O, Ne and A ions. The variation o track width with heigth was measured for different development times. Amidol and 1D19 produced large variations with time

mpared with developers containing no solvent for AgBr. The scrimination of heavy-ion tracks is discussed in the light of these sults. E.J.Burge

DEPOLARIZATION OF μ^--MESONS IN NIKFI EMULSIONS BJECTED TO A MAGNETIC FIELD OF 10^4 Oe. See Abstr. 2076

2002 PRESENT STATUS OF SCINTILLATION CHAMBERS. G.T.Reynolds.
E Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 115-20 (July-ot., 1960). [Proceedings of the Seventh Scintillation Counter mposium, Washington, February, 1960].
The advantages of imaging the tracks of high-energy particles scintillation counters have been recognized for some years. cent developments in scintillator techniques and improvements in image intensifiers required have resulted in usable systems. e basis for the design of these systems, and their specific vantages to high-energy nuclear physics are discussed. Several perimental proposals are described quantitatively to illustrate advantages and limitations of the technique. Accomplishments various groups working in this field are summarized.

2003 ELECTRON MICROSCOPE OBSERVATIONS OF FISSION FRAGMENT TRACKS IN THIN FILMS OF UO_2. S.Noggle and J.O.Stiegler.
appl. Phys. (USA), Vol. 31, No. 12, 2199-2208 (Dec., 1960).
Electron microscope studies of the tracks produced by fission agments in thin films of UO_2 established a 100% detection efficiency r fission events in films 100 A or less in thickness. A background xture decreases the efficiency in thicker films. The tracks gister in the films primarily as a result of a redistribution of rface material arising from the disturbance produced by the con-nuous loss of energy of the fragment by electron excitation and nization. The minimum rate of energy loss which registers as a ack in the film is on the order of 1000 eV/A. Track length distri-tions, however, suggest that as yet unrecognized free surface fects may also contribute to the track registration.

NUCLEAR FIELD THEORY

2004 ON A POSSIBLE GENERALIZATION OF QUANTUM MECHANICS. T.Kaneno.
ogr. theor. Phys. (Japan), Vol. 23, No. 1, 17-31 (Jan., 1960).
An attempt is made to enlarge the number field underlying ıntum mechanics from complex to quaternion. It is not impossible construct quaternion quantum mechanics in quite a similar manner the usual complex quantum mechanics, though some limitations e necessary for the position of factors. Further, as a special se, the charge properties of the spin-0 particles are considered. is example may show some new way to generalize the concept of charge of the elementary particles without adoption of the iso-ıce.

2005 ON THE WEAK INTERACTIONS. Y.Katayama.
. Acad. Brasil. Cienc., Vol. 32, No. 2, 195-205 (1960).
A summary of the most important facts about weak interactions, ether with a discussion of some more speculative questions: versality, weak interactions at high energies, and the origin of ity violation. J.C.Taylor

2006 THE ISOREPRESENTATION OF LEPTONS. J.Lukierski.
1. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), . 8, No. 8, 553-7 (1960).
Describes two attempts to assign isotopic spin to leptons, and to write their interactions in a unified manner. J.C.Taylor

539.11

2007 THE ACTION OPTION AND A FEYNMAN QUANTI-ZATION OF SPINOR FIELDS IN TERMS OF ORDINARY NUMBERS. J.R.Klauder.
. Phys. (USA), Vol. 11, No. 2, 123-68 (Oct., 1960).
The Feynman sum represents a convenient formulation of quantum mechanics for Bose fields, but, to secure a similar formulation applicable to fermion fields, it has been necessary to use "anticommuting c-number" field histories to insure the anticommutivity of the quantum field operators. Here, a method is presented to sum over histories for spinor fields which (1) employs the familiar classical c-number expression for the action, (2) predicts anti-commutation rules and Fermi statistics, and (3) retains the invariance of the theory under a change in phase of the complex ψ field. The Feynman procedure demands a numerical action value for histories outside the domain for which the action integral was intended, for example, for histories which are discontinuous with respect to space or time. One is therefore presented with an "action option", i.e. the action value for such "unruly" histories may be defined in various ways. Depending on the choice made, the resulting quantum theory can be made to manifest either Bose or Fermi statistics. This ambiguity is inherent in the formalism itself. However, the proper choice to extend the classical information is most readily determined by constructing the sum over histories by a summation over multiple products of matrix elements of the unitary operator which advances the state an infinitesimal time. This summation need not be limited to the familiar discrete basis vectors; instead a "generalized representation" can be employed which involves, for each fermion degree of freedom, continuously many, non-independent vectors. When a suitable parameterization is chosen for this "overcomplete family of states" the multiple product of matrix elements for a given history reduces to the exponential of the appropriate action functional evaluated for that history. A unified formulation of both statistics for the Schrödinger field is presented which includes a detailed account of the necessary properties of the overcomplete family of states and a derivation of the functional measure for fermion fields. The propagator and a functional expression for the ground state of the neutrino field are presented as applications of the method to relativistic spinor fields.

2008 ON ASYMPTOTIC BEHAVIOR OF VACUUM EXPECTATION VALUES AT LARGE SPACE-LIKE SEPARATION. H.Araki.
Ann. Phys. (USA), Vol. 11, No. 2, 260-74 (Oct., 1960).
The asymptotic behaviour of truncated vacuum expectation values at large space-like separation is studied. Truncated vacuum expectation values are vacuum expectation values of products of field operators where the vacuum structure is subtracted out. It is shown under conventional assumptions of relativistic quantum field theory that the truncated vacuum expectation values at equal time tend to zero exponentially as the largest distance R of points tends to infinity with an exponent mR where m is the lowest mass and is assumed positive. It is also shown that the truncated vacuum expectation values tend to zero in an averaged sense faster than any power of R if the points are divided into two groups and separated by large space-like distance R where the points need not lie on a common space-like hypersurface.

2009 UNIQUENESS PROPERTY OF THE TWOFOLD VACUUM EXPECTATION VALUE. P.G.Federbush and K.A.Johnson.
Phys. Rev. (USA), Vol. 120, No. 5, 1926 (Dec. 1, 1960).
It is shown under general assumptions that if the one-body Green's function equals its free-field value the theory is that of a free field.

2010 OPERATOR GAUGE TRANSFORMATIONS IN QUANTUM ELECTRODYNAMICS. H.Rollnik.
Z. Phys. (Germany), Vol. 161, No. 4, 370-9 (1961). In German.
The formulation of operator gauge transformations is discussed. Using some simple consequences of charge conservation and the equal time commutation relations, it is possible to give an exact meaning to a certain class of such transformations. This class contains all the special cases which have importance for practical calculations. Only renormalized Heisenberg operators are used throughout.

2011 MAXWELL'S EQUATIONS AND MATRIX ELEMENTS IN QUANTUM ELECTRODYNAMICS. H.A.Venables.
Canad. J. Phys., Vol. 39, No. 1, 141-4 (Jan., 1961).
Matrix elements of second-order processes in quantum electrodynamics are obtained directly from the use of Maxwell's and Dirac's equations.

2012 GAUGE INVARIANCE, THE MASS OF THE PHOTON AND THE ASYMPTOTIC FORM OF THE PHOTON PROPAGATOR. B.Jouvet.
C.R. Acad. Sci. (France), Vol. 251, No. 10, 1119-21 (Sept. 5, 1960). In French.

A solution is proposed of the old paradox of the incompatability of gauge invariance with the existence of a photon bare-mass. An equation is deduced which determines the asymptotic form of the photon propagator. J.C.Taylor

2013 VARIATION OF THE ADIABATIC INVARIANT OF A PARTICLE IN A MAGNETIC FIELD. I.
A.M.Dykhne and V.L.Pokrovskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 373-7 (July, 1960). In Russian.

The change of magnetic angular momentum of a particle moving in an axially symmetric inhomogeneous magnetic field is considered. The field tends to constant values at infinite distance and the particle is taken to begin at $-\infty$. The usual model Hamiltonian, neglecting curvature of the lines of force, is employed. By a change of variables the Schrödinger equation is made approximately separable and the residue is treated in perturbation theory. The small parameter of expansion is the logarithmic space derivative of the Larmor frequency. [English translation in: Soviet Physics—JETP (USA), Vol. 12, No. 2, 264-7 (Feb., 1961)]. D.W.L.Sprung

2014 SYMMETRY THEOREMS FOR ISOSPIN-INVARIANT REACTIONS. M.Peshkin.
Phys. Rev. (USA), Vol. 121, No. 2, 636-42 (Jan. 15, 1961).

Symmetry theorems, analogous to those well known for angular distributions and correlations, are given for isospin-invariant reactions starting from an initial state of limited complexity. Detailed calculations are carried out when the initial-state isospin does not exceed $\frac{3}{2}$. A statistical generalization is given for averages over experiments starting from different charge states. Some properties of the irreducible tensor operators which arise from recoupling the angular momentum operator to itself are discussed.

2015 "MINIMAL PROPERTY" OF ELECTROMAGNETIC INTERACTION FOR SPIN $\frac{3}{2}$ PARTICLES. A.Komar.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 101-3 (Jan., 1961).

The possibility of the extended electromagnetic interaction for spin $\frac{3}{2}$ particles with terms in the Lagrangian depending directly on electromagnetic field tensor $F_{\mu\nu}$ is considered. It is shown that inclusion of such terms leads in all variants to a non-consistent theory, thus making the minimal electromagnetic interaction the only one allowed.

2016 PHASE SHIFTS OF HIGH-ENERGY DIRAC AND KLEIN–GORDON PARTICLES. T.Tietz.
Acta phys. Hungar., Vol. 12, No. 1, 85-8 (1960).

Formulae for extreme relativistic energies are derived. W.A.Hepner

2017 THE PHENOMENOLOGICAL BARYON–BARYON SCATTERING THEORY AND THE RELATIVE PARITY DETERMINATION. A.Deloff and J.Wrzecionko.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 464-74 (Nov. (2), 1960).

The reactions $a + b \to c + d$ with four baryons are considered. Two cases of relative intrinsic parities $I_aI_b = \pm I_cI_d$ are taken into account; the phenomenological S-matrix technique is used for obtaining the cross-section and polarizations. An approximation in which in the initial state only the S-wave is present is discussed. In this approximation the cross-section for unpolarized particles is isotropic and the polarizations in the final state are zero when $I_aI_b = I_cI_d$ and proportional to $\sin 2\theta$ when $I_aI_b = -I_cI_d$. Some experimental tests for the relative parity determination are proposed.

2018 SOME TOPICS REGARDING THE STRONG INTERACTIONS OF STRANGE PARTICLES.
D.Amati and B.Vitale.
Fortschr. Phys. (Germany), Vol. 7, No. 7, 375-421 (1959).

This is a review article, mainly containing information known before the end of 1958. The first section summarizes experimental information on mass, decay, spin and charge independence. The second section discusses a number of possible ways of determining the relative parities of strange particles, including the use of K–N and $\bar{K}$–N dispersion relations. The final section deals with some forms of "global" symmetry that have been proposed, including possible tests. There is a subsection on parity conservation in strong interactions. J.C.Taylo

2019 INVESTIGATION OF THE FIVE-POINT FUNCTION.
L.F.Cook, Jr and J.Tarski.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 585-8 (Dec. 15, 1960).

Reports a study of the singularities of the five-point Feynman amplitudes, restricted to single-loop diagrams without crossed lines and to four specific processes with one configuration of momenta for each process. A brief summary and a discussion of the results are given. F.Herbu

2020 A DISCUSSION OF DUAL DIAGRAMS IN PERTURBATION THEORY. P.V.Landshoff.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 129-35 (Oct. (4) 1960).

A discussion is given of the dimensions of the space in which dual diagrams are drawn and of restrictions arising for singularities in scattering processes in which more than one particle is produced.

2021 THE INHOMOGENEOUS WAVE EQUATION IN LOCAL RELATIVISTIC QUANTUM FIELD THEORY.
A.S.Wightman and H.Epstein.
Ann. Phys. (USA), Vol. 11, No. 2, 201-39 (Oct., 1960).

The equation $(\Box + m^2)u(x) = j(x)$, where $j(x)$ is a known local field is solved for $u(x)$ in the form $u(x) = u^{(0)}(x) - \int \Delta_R(x-x')dx'j(x')$ where $u^{(0)}(x)$ is a free field. The possibility of choosing $u^{(0)}(x)$ so that $u(x)$ is local is studied by considering vacuum expectation values containing $j(x)$ and $u(x)$. It is shown that in the case $j(x) = g\phi^2(x)$, $\phi(x)$ a free field, no $u^{(0)}(x)$ with the desired properties exists. The argument is generalized to the case of the equations of a neutral vector meson field, B, interacting with a spinor field, χ:

$$(\gamma^\mu \partial_\mu + m)\chi(x) = ie\,\gamma_\mu A^\mu(x)\psi(x),$$

$$\partial_\nu[\partial^\nu B_\mu - \partial_\mu B^\nu] + \kappa^2 B_\mu(x) = ie{:}\bar{\psi}^\dagger(x)\gamma_\mu\psi(x){:}.$$

2022 CONTRIBUTION TO THE PROBLEM OF PAIRING EFFECTS WITH ANGULAR MOMENTA DIFFERENT FROM ZERO. V.M Galitskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1157-9 (Oct., 1960). In Russian.

Systems with bound pairs of particles in the Fermi surface are considered. It is assumed that the interaction is attractive only for states with nonzero angular momentum l. The ground state is then built up of pairs with angular momentum l. Under some restrictions (for instance, that all the pairs are in the same state), it is shown that in the energetically most favourable case the angular momentum projections are $\pm l$; this property can be called orbital paramagnetism. The case of a system having a definite value of total orbital angular momentum is also examined. The results are not considered as final. Some conjectures are made about the superconducting properties of the system. [English translation in: Soviet Physics—JETP (USA)]. F.He

ELEMENTARY PARTICLES

2023 ALGEBRAIC CLASSIFICATION OF ELEMENTARY PARTICLES AND INTERACTIONS. J.M.Souriau.
C.R.Acad. Sci. (France), Vol. 251, No. 16, 1612-14 (Oct. 17, 1960). In French.

This classification involves a hierarchy of spinor representations, the first being a representation of a three-dimensional space corresponding to the three neutral mesons. Some consequences for weak interactions are described. The connection with isotopic spin is not discussed. J.C.Tay

2024 MASS AND LIFETIME OF UNSTABLE PARTICLES.
R.Jacob and R.G.Sachs.
Phys. Rev. (USA), Vol. 121, No. 1, 350-6 (Jan. 1, 1961).

The relationship between the properties of the propagator of an unstable particle and the observation of mass and lifetime is considered. For illustrative purposes a model of a scalar (or pseudoscalar) particle (θ) weakly coupled to two pions is treated. The

pagator is shown to have a simple pole on the second (unphysical) mann sheet and it is assumed, as suggested by Peierls (1954), this is generally the case. By analysis of a prototype experi- t in terms of wave packets, it is shown that the measured mass lifetime are determined by the real and imaginary parts of the , respectively. Nonexponential terms occur in the lifetime curve s well-known. These are shown to be related to the uncertainty ne time of the production or detection event under normal cir- stances. This conclusion is similar to those of Levy and of winger, but more closely related to experimental conditions. In icular it is found that the wave packets introduce a "mass filter" somewhat different manner from that suggested by Schwinger. er special conditions at $t^{-3/2}$ term may occur in the amplitude would be unimportant in magnitude for, say, the decay of a nge particle. It is noted that such nonexponential decay curves ht occur for certain low-energy nuclear processes. Considera- is also given to the treatment of two degenerate, unstable part- s, such as the neutral K-mesons. The general method for hand- the problem leads, in the weak-coupling limit, to the same re- as the Wigner—Weisskopf method.

2025 INELASTIC INTERACTIONS IN THE FINAL STATE AND NEAR-THRESHOLD PECULIARITIES.
Lapidus and Chzhou Guan-chzhao [Chou Kuang-chao].
eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 364-72 (Aug., 1960). Russian.

It is shown that near the threshold of the reaction $C + D \rightarrow E + F$, onmonotonous energetic variation may arise in the energy spect- n of particles a produced in reactions of the type $A + B \rightarrow a + C + D$. an example the spectrum of K-mesons produced in the $N \rightarrow \Lambda + N + K$ reaction is analysed for Λ—N pair energies lying r the threshold of the process $\Lambda + N \rightarrow \Sigma + N$. The energy spec- m of K-mesons produced by unpolarized nucleons and the polari- ion of baryons produced by polarized nucleons in the process $p \rightarrow \Lambda + N + K$ are derived. Cases of nonmonotonous energetic iation in the particle spectra are discussed for a number of other ctions. Creation of Y—K pairs in (n,p) collisions is discussed and case of a scalar K-particle considered. [English translation in: iet Physics—JETP (USA), Vol. 12, No. 2, 258-63 (Feb., 1961)].

2026 AN EXTENSION OF THE TRANSFER MATRIX METHOD TO A BEAM TRANSPORT SYSTEM CONTAINING A ENOID. D.N.Edwards and B.Rose.
lear Instrum. and Methods (Internat.), Vol. 7, No. 2, 135-44 y, 1960).

The transfer matrix method of calculating beam transport olems is outlined, and extended to the case in which one of the nents is a solenoid, as is used in certain polarization experi- ts. The theoretical results are compared with measurements le with a proton beam and semi-quantitative agreement is found.

iotons

2027 ANGULAR DISTRIBUTION OF REFLECTED GAMMA-RADIATION. U.Ulmanis.
. PSR Zinat. Akad. Vestis (USSR), No. 9(158), 67-72 (1960). ussian.

The angular distribution and its dependence on thickness and ic number of the scattering medium as well as on the energy e primary radiation were studied using a scintillation spectro- er as detector. The following γ-sources were used: Tu^{170}, Se^{75}, ^{123}, Cs^{137}, $Eu^{152, 154}$, Co^{60}. The incidence of gamma-rays was endicular to the scattering medium. Background and spectral itivity of the spectrometer were accounted for in the treatment perimental results. It was found that the angular distribution nds on the thickness and atomic weight of the scatterness and easing radiation energy, the distribution of the reflected radia- approaches the cosinusoidal. With low-energy incident radiation ^{70}), the angular distribution of the reflected radiation practically not depend on the atomic number and thickness of the scattering um. An equation for theoretical estimation of the angular dis- tion is proposed, which may also serve in interpreting the acter of experimental curves.

MOMENTUM DISTRIBUTIONS OF PHOTONS FROM TRONS ANNIHILATING IN ALKALI HALIDES.
bstr. 954

ABSOLUTE MEASUREMENT OF γ-QUANTA.
2028 T.Nakamura, K.Fukunaga, K.Takamatsu and S.Yasumi.
Mem. Coll. Sci. Univ. Kyoto A (Japan), Vol. 29, No. 2, 141-51 (Sept., 1959).

Absolute measurement of γ-quanta from the Li—p reaction was performed by Hough's method (Abstr. 3022 of 1950). Using this result, the efficiency of the γ-monitor was calibrated, and a previously used Pb thick-walled G—M counter was also calibrated. Discussions are given on the determination of the absolute number of γ-quanta with the previous γ-counter as well as on the absolute cross-section values of (γ, n) reactions.

A PORTABLE GAMMA-RAY SPECTROMETER.
2029 A.R.Jones.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 96-101 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].

The spectrometer comprises a single-channel scanning pulse-height analyser, high-voltage supply, photomultiplier tube and NaI crystals. The circuits are transistorized and driven from recharge-able batteries. The analyser contains a linear amplifier, window discriminator, count-rate circuit and miniature recorder. The recorder and window discriminator are driven synchronously to display a spectrum in twelve minutes. The circuits, application and performance are discussed.

PRECISION MEASUREMENT IN GAMMA-RAY
2030 SPECTROSCOPY.
G.A.Bartholomew, J.W.Knowles and G.E.Lee-Whiting.
Rep. Progr.Phys. (GB), Vol. 23, 454-543 (1960).

Gamma-ray spectrometers suitable for precision measurements, i.e. those capable of an energy resolution exceeding 1% and an energy accuracy better than 0.2%, are discussed according to the γ-ray interaction used: coherent scattering (crystal diffraction), photoelectric effect, Compton effect, and pair production. Leading instruments of each type are described and the energy range, resolution, efficiency function, and precision in energy and intensity measurement are discussed and, in some cases, ways of improving existing instruments are indicated. The suitability of the various instruments for different applications is considered and, where more than one type of instrument can be used under identical conditions, attempts are made to compare their relative merits.

CESIUM IODIDE AS A GAMMA RAY SPECTROMETER.
2031 C.T.Schmidt.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 25-8 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February 1, 1960].

Thallium-activated cesium iodide is discussed as a gamma-ray spectrometer which should have advantages over thallium activated sodium iodide at high gamma-ray energies. Data are presented which were obtained with a cylinder of thallium activated cesium diodide (5 in. dia. × $3\frac{1}{2}$ in. high) viewed with a 3 in. diameter photomulti-plier. These data include linearity of response from 80 keV to 7.2 MeV, resolution as a function of gamma-ray energy, and photo-fractions as a function of gamma-ray energy for collimated radiation.

NaI(Tl) SUMMING COMPTON SPECTROMETER.
2032 H.Takekoshi.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1280-5 (Dec., 1960).

Describes a new method of measuring gamma-ray energy by using two sodium iodide crystals. The sum of two pulses is to be taken: one from a crystal which scatters gamma-rays by the Compton effect, and the other from a second crystal which receives the scattered photon. In comparison with the scintillation Compton spectrometer hitherto developed, this method is good both in efficiency and in resolution.

TOTAL ABSORPTION GAMMA-RAY SPECTROMETERS
2033 UTILIZING ANTICOINCIDENCE SHIELDING.
R.W.Perkins, J.M.Nielsen and R.N.Diebel.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1344-9 (Dec., 1960).

Two types are described. One consists of a 5 in. diameter by 5 in thick NaI(Tl) well crystal enclosed in a 26 in. diameter by 30 in. high plastic phosphor. The plastic phosphor serves as the anti-coincidence guard. The second spectrometer consists of a 3 in. dia-meter by 3 in. thick NaI(Tl) crystal with a $9\frac{3}{8}$ in. diameter by $8\frac{1}{2}$ in. thick NaI(Tl) well crystal as its anticoincidence guard. With the

anticoincidence shielding, and a point source in the well of the 5 × 5 in. crystal, the Compton portion of the Zn^{65} spectrum is reduced by a factor of about 5, while the Compton portion of the Co^{60} spectrum (below 1 MeV) is reduced by factors of 20 to 25. With these point sources on top of the 3 × 3 in. solid crystal, these Compton regions are reduced by factors of about 4 and 14, respectively. These anticoincidence shielding arrangements also provide background reductions of a factor of 2 to 5 in in the energy region below 3 MeV. The response of these spectrometers to other gamma-ray energies is included. The photomultiplier mounting arrangements for the large NaI(Tl) and plastic phosphors, and the resolutions of the plastic and NaI(Tl) crystal are discussed.

2034 A TOTAL ABSORPTION GAMMA RAY SPECTROMETER COMBINING SODIUM IODIDE AND PLASTIC SCINTILLATORS. W.H.Ellett and G.L.Brownell.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 56-62 (April, 1960).

An 18 in. × 18 in. plastic well scintillator is used to monitor the escape radiation from a 5 in. diam. NaI well crystal. Coincident events in both scintillators are rejected by means of an anticoincidence circuit. The detectors are mounted in a two-ton lead and mercury shield so they can be used for the radioassay of low activity samples. Design of electronic equipment used with the plastic scintillators is considered and data presented on the effectiveness of the anticoincidence mantle in improving the performance of the NaI crystal by (a) reducing the Compton spectrum (b) increasing its efficiency as a sum spectrometer and (c) reducing its background spectra. Expressions are derived for the efficiency of the plastic mantle in detecting escape radiation from the NaI crystal and compared to experimental data.

ANGULAR DISTRIBUTION AND POLARIZATION OF THE RADIATION EMITTED BY ELECTRONS ACCELERATED IN A SYNCHROTRON. See Abstr. 1944

2035 VAVILOV–CHERENKOV EFFECT IN UNIAXIAL CRYSTALS. Ch.Muzikarzh [Č.Muzicář].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 163-70 (July, 1960). In Russian.

The Vavilov–Cherenkov radiation emitted by an electric charge moving uniformly in an arbitrary direction relative to the optical axis of a uniaxial crystal is considered. The shape of cones for the normals of the ordinary and extraordinary waves is studied and simple expressions are derived for the energy of the investigated waves. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 1, 117-22 (Jan., 1961)].

2036 RADIATION FROM A CHARGED PARTICLE MOVING THROUGH A PLATE. V.E.Pafomov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 134-7 (July, 1960). In Russian.

Results of the calculation of the angular distribution of the radiation emitted by a charged particle passing through an isotropic ferrodielectric plate and through a crystalline plate are presented. In the case of thick plates, the main contribution is due to the Vavilov–Cherenkov radiation. An investigation of the solution shows that in the frequency range in which the projections of the wave vector and the Poynting vector on the particle velocity have opposite signs, the Vavilov–Cherenkov radiation is emitted through the back wall of the plate. The radiation emitted by a charged particle moving through thin dielectric plates is also considered. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 1, 97-9 (Jan., 1961)].

2037 EFFECT OF MULTIPLE SCATTERING ON TRANSIENT RADIATION. V.E.Pafomov.
Dokl. Akad. Nauk SSSR, Vol. 133, No. 6, 1315-18 (Aug. 21, 1960). In Russian.

The energy spectrum of the radiation produced when a charged particle passes from a medium to a vacuum is investigated. Multiple scattering of the particle is found to have an effect, particularly on the angular distribution and cut-off and therefore on the total energy radiated. This latter is found to vary linearly with particle energy below a certain point and quadratically above it. [English translation in: Soviet Physics–Doklady (USA)]. J.S.Dowker

Electrons

2038 THE STOCHASTIC PROBLEM OF ELECTRON–PHOT CASCADES INCLUDING POLARIZATION.
N.R.Ranganathan and R.Vasudevan.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 650-6 (Nov., 1960).

The theory of electron–photon cascades was studied by the product density functions well known in stochastic theory so as to include a description of the state of polarization of the multiplying particles. Defining a suitable longitudinal polarization product density function of degree one, an expression for the mean numbe of longitudinally polarized particles produced in a medium from 0 to t was obtained. Equations for product densities of degree two were briefly dealt with.

2039 ELECTRON SCATTERING FROM THE PROTON. F.Bumiller, M.Croissiaux and R.Hofstadter.
Phys. Rev. Letters (USA), Vol. 5, No. 6, 261-3 (Sept. 15, 1960).

A new 180° double focusing magnetic spectrometer with a me radius of curvature of 72 in. was used, together with an older 36 spectrometer, to measure the cross-section as a function of angl for scattering of 600-900 MeV electrons on protons. Cherenkov counters were used as detectors. R.E.Me

2040 LONGITUDINAL POLARIZATION OF BETA-ELECTRONS. P.E.Spivak and L.A.Mikaelian.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 475-90 (Nov. (2), 1960).

The longitudinal polarization of beta-electrons of P^{32}, In^{114}, Sm^{153}, Lu^{177}, Ho^{166} and Au^{198} was measured by the Mott scattering method at 300 to 340 keV. Differences up to 10% were detected i the degree of polarization for the nuclides under investigation. It was also found that the absolute polarization values lie in the inte val –(0.86-0.97) v/c. The error in absolute measurements, ±3% does not include possible inaccuracies of theoretical calculation connecting the degree of polarization and scattering asymmetry.

2041 A NEW DESIGN FOR A BETA-RAY SPECTROGRAPH FOR RELATIVE MEASUREMENTS.
E.Karlsson and K.Siegbahn.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 113-23 (May, 1960).

A new semicircular beta-spectrograph is described. The focusing field is obtained from a well-stabilized electromagnet. The instrument is provided with special arrangements for caret relative measurements. The energy calibration can be made ver reproducible by means of a special source exchange arrangemen and the recording film can be exposed by sections along its lengt Resolution and transmission characteristics are discussed and a method for using mass-separated sources is presented.

2042 SPIN–MOMENTUM CORRELATIONS IN POSITRON–ELECTRON SCATTERING. C.Fronsdal and B.Jakši
Phys. Rev. (USA), Vol. 121, No. 3, 916-19 (Feb. 1, 1961).

The imaginary part of the fourth-order Bhabha ($e^+ - e^-$) scat matrix element interferes with the (real) second-order matrix element, to produce a sixth-order dependence of the cross-secti on the spin of one of the particles (after summing over the spins the other three particles). The process of extracting the imagin part of the fourth-order matrix element is presented in some de in one of the graphs (vacuum polarization).

2043 MEASUREMENT OF THE ANNIHILATION-IN-FLIGH CROSS SECTION AT 0° FOR 8.5 MeV POSITRONS.
F.D.Seward, C.R.Hatcher and S.C.Fultz.
Phys. Rev. (USA), Vol. 121, No. 2, 605-9 (Jan. 15, 1961).

The differential cross-section at 0° was measured. The pos were created in a thick Ta target which was bombarded by 20 M electrons from a linear accelerator. They were directed onto a Be target where annihilation occurred, and the annihilation phot were measured by use of a thick-crystal spectrometer. The measured value for the cross-section is 1.3 ± 0.2 barns/steradi per electron, which is in agreement with theory,

2044 RADIATIONS FROM HIGH-ENERGY POSITRONS INCIDENT ON A BERYLLIUM TARGET.
C.P.Jupiter, N.E.Hansen, R.E.Shafer and S.C.Fultz.
Phys. Rev. (USA), Vol. 121, No. 3, 866-70 (Feb. 1, 1961).

The energy spread and yields of nearly monoenergetic phot

arious energies produced by the annihilation in flight of relati-
ic positrons were experimentally determined using a 6 in. long
in. diameter NaI(Tl) crystal spectrometer. Photon lines with
nergy spread of a few percent are reported. Yields of positrons
monoenergetic photons in the energy range from 2 to 14 MeV
e measured. The bremsstrahlung spectra from 6.5 MeV posi-
s and electrons were compared and the yields and spectral distri-
ons were found to agree within the experimental error.

2045 DIRECT PRODUCTION OF ELECTRON–POSITRON PAIRS BY HIGH-ENERGY ELECTRONS.
.Tumanian, G.S.Stoliarova and A.P.Mishakova.
mic Ray Conference, Moscow, 1959, English Edition (see Abstr.
7 of 1960) Vol.II, p. 296-301.
The calculation of the absolute number of pseudo-tridents pro-
ed by high-energy electrons is performed by the Monte Carlo
hod. The number obtained is used for calculating, from experi-
tal results, the cross-section of direct production of pairs.
C.F.Barnaby

2046 ANGULAR CORRELATION OF GAMMA QUANTA FROM ELECTRON–POSITRON ANNIHILATION IN BISMUTH.
.Dekhtyar and V.S.Mikhalenkov.
l. Akad. Nauk SSSR, Vol. 133, No. 1, 60-3 (July 1, 1960). In
sian.
The experiment was carried out on a single plane crystal of
2 mm thick, using positrons from Na^{22} and scintillation counters
detection, in coincidence. The mean maximum momentum of
trons in the plane of the crystal at each 15° interval, and the
ribution of electron states were deduced and agreed well with
heoretical Fermi surface. The 16% anisotropy of the Fermi
ace in the crystal plane also agreed. [English translation in:
et Physics–Doklady (USA)]. D.W.L.Sprung

ucleons

2047 THE STRUCTURE OF NUCLEONS.
D.L.Blokhintsev, V.S.Barashenkov and B.M.Barbashov.
ekhi. fiz. Nauk (USSR), Vol. 68, No. 3, 417-47 (July, 1959). In
sian. English translation in Soviet Physics–Uspekhi (USA)
2, No. 4, 505-25 (July-Aug., 1959).
A review article dealing with the electromagnetic and mesonic
cture of the nucleon. C.J.Batty

2048 ISOSPIN FOR $N + \bar{N} \rightarrow K + \bar{K} + k\pi$ AND SIMILAR REACTIONS. H.Pilkuhn.
lear Phys. (Internat.), Vol. 22, No. 1, 168-76 (Jan., 1961).
For antiproton annihilation into a $K\bar{K}$ pair and k pions, multiple
production in nucleon–nucleon and pion–nucleon collisions,
ransition rates into states with given charge configurations of
outgoing particles are expressed in terms of isospin amplitudes.
the pions' states, representations of the permutation group are
loyed. Interference terms are discussed, and explicit expres-
s are given for k up to 5.

2049 SCATTERING MATRIX FOR NUCLEONS ON SPIN ONE TARGET. P.Vinternitts.
ksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1476 (Nov., 1960).
ssian.
A representation of the scattering matrix due to Budyanskii
r. 5194 of 1958) is stated to be partly incorrect. [English trans-
n in: Soviet Physics–JETP (USA)]. D.W.L.Sprung

2050 RELATIVISTIC FORMULA FOR THE SPIN CORRELATION COEFFICIENT C_{KP}. D.W.L.Sprung.
. Rev. (USA), Vol. 121, No. 3, 925-6 (Feb. 1, 1961).
A formula due to Stapp (Abstr. 6334 of 1956) for the spin
lation coefficient C_{KP} in nucleon–nucleon scattering is
cted. Formulae for the other triple-scattering and unpolarized-
ent-beam correlation parameters are included. The formulae
pplicable when the nonrelativistic scattering matrix formalism
lfenstein (Abstr. 4139 of 1952) is used to analyse triple-scatter-
xperiments at higher energies where relativistic effects are not
gible. The definition of the correlation coefficients in the
vistic case is discussed.

Protons

2051 THE GYROMAGNETIC RATIO OF THE PROTON.
J.H.Nelson.
J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 292 (Dec., 1960).
Letter, substantially as follows: In order that all measurements of the intensity of the geomagnetic field, made by investigators and observers throughout the world, might be referred to the same fundamental physical constant, the following resolution was adopted at the XII General Assembly of the International Union of Geodesy and Geophysics in Helsinki, during the period 25 July-6 August 1960: The International Association of Geomagnetism and Aeronomy, considering the need for a universal agreement regarding the value of the gyromagnetic ratio of the proton for measurements of the geomagnetic field, strongly recommends that, pending the agreement and specification by an appropriate international scientific organization of a final value, all measurements of the geomagnetic field with a proton free-precession magnetometer, using pure water as a proton sample, shall be based on the following value of the gyromagnetic ratio: 2.67513×10^4 rad/gauss sec.

2052 ANALYSIS OF SOME INELASTIC p–n INTERACTIONS AT AN ENERGY OF 9 BeV.
Zh.S.Takibaev, V.A.Botvin and I.Ya.Chasnikov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 571-2 (Nov. 21, 1960).
In Russian.
Angular distributions of the π-reaction products are discussed. Marked asymmetrics are found. [English translation in: Soviet Physics–Doklady (USA)]. J.S.Dowker

2053 TOTAL CROSS-SECTIONS FOR p, $\bar{p}$, $K^{\pm}$ AND $\pi^{\pm}$ ON HYDROGEN BETWEEN 3 AND 10 GeV/c.
G.von Dardel, D.H.Frisch, R.Mermod, R.H.Milburn, P.A.Piroué, M.Vivargent, G.Weber and K.Winter.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 333-6 (Oct. 1, 1960).
Reports a first investigation of the behaviour of the total cross-sections of hydrogen for elementary particles in the momentum interval 3 to 10 GeV/c, using a scattered out beam of the CERN proton-synchrotron. p, $\bar{p}$, K^+, K^-, π^+ and π^- particles, incident on a hydrogen target, were distinguished by momentum and velocity selection using a bending magnet and a gas Cherenkov counter. The cross-sections generally appear to follow the trend suggested by lower energy data and do not show any resonant behaviour. However, the K^+–p results are difficult to reconcile with the lower energy measurements of Burrowes et al. (Abstr. 6043 of 1959) unless some pronounced structure is present. The experiment indicates that the cross-sections all tend to approach constant values at high energies, although the limiting equality of particle and antiparticle cross-sections predicted by Pomeranchuk (Abstr. 8219 of 1958) has not yet been reached at 10 GeV/c in the case of K-mesons and nucleons, whilst the pion cross-sections are equal within the systematic uncertainty. J.D.Dowell

2054 RELATIONS IN PROTON–PROTON SCATTERING, BETWEEN THE EXPERIMENTAL QUANTITIES AND THE COEFFICIENTS OF WOLFENSTEIN'S MATRIX M.
M.Lacombe.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1768-70 (Oct. 24, 1960).
In French.
Writes various experimental quantities in terms of the spin dependence of the scattering amplitude. R.J.N.Phillips

2055 THE SPIN–ORBIT POTENTIAL IN PROTON–PROTON SCATTERING. D.W.L.Sprung and J.B.Willis.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 539-44 (Oct., 1960).
An extension of the potential model for proton–proton scattering to relativistic energies was proposed. The treatment was based on a truncated two-particle Dirac equation, from which an approximate, semi-relativistic wave equation was derived by reduction to large components. Using a potential related to that of Gammel and Thaler, numerical calculations of p–p scattering at 635 and 1000 MeV were carried out. Reasonable total and differential cross-sections were obtained, but the polarization disagreed qualitatively with experiment. Agreement of the polarization could be obtained by reducing the spin–orbit splitting for the F-phases. It appeared possible to fit the experimental data up to 1000 MeV by choosing a spin–orbit potential which was attractive (in $J = L + 1$ states) at short distances, but has a repulsive tail.

2056 QUANTITATIVE EVIDENCE OF ONE-PION EXCHANGE EFFECTS IN p–p SCATTERING. P.S.Signell.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 474-6 (Nov. 15, 1960).

A nine-parameter phase shift analysis of the 310 MeV data was carried out, starting from the solutions 1 and 2 MacGregor et al. (Abstr. 2543 of 1960), adding in the one-pion pole term with fixed $g^2 = 12.0$ and varying the virtual quantum mass to obtain a best fit. In each case the measure of fit versus mass curve is non-parabolic, and reaches a shallow minimum at a value about half the real pion mass. A similar analysis of 95 MeV data, varying both g^2 and the mass, leads to a definite best fit at $g^2 \cong 14$ and mass $\cong 125$ MeV, giving confidence in the identification of the virtual particle with the real pion. D.W.L.Sprung

2057 THE SPIN CORRELATION COEFFICIENT IN p–p SCATTERING AT 310 MeV AT 90° c.m.
I.M.Vasilevskii, V.V.Vishnyakov, É.Iliesku and A.A.Tyapkin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 889-91 (Sept., 1960). In Russian.

The parameter C_{nn} (90°) was measured as $0.84 \pm {}^{0.10}_{0.22}$; it replaces a preliminary value of 0.7 ± 0.3. While favouring solution "two", the new value is high compared with the predictions of the modified phase-shift analysis of Stapp et al. (Abstr. 2543 of 1960). The authors consider that this measurement invalidates the 9-parameter analysis (which predicts 0.41 for both solutions "one" and "two"), and that further measurements are needed to obtain a unique set of phase shifts. [English translation in: Soviet Physics - JETP (USA)]. D.W.L.Sprung

DEPOLARIZATION OF A BEAM OF POLARIZED PROTONS IN A SYNCHROTRON. See Abstr. 1946

Neutrons

2058 THE ELECTRON ASYMMETRY IN THE BETA DECAY OF POLARIZED NEUTRONS. M.A.Clark and J.M.Robson.
Canad. J. Phys., Vol. 39, No. 1, 13-21 (Jan., 1961).

The coefficient of the angular correlation between the electron direction and the neutron spin direction in the beta decay of the neutron was measured using a beam of polarized neutrons. The coefficient of this correlation is -0.09 ± 0.05. This implies that C_A/C_V, the ratio of the axial vector to vector coupling constants in neutron decay, is equal to -1.20 ± 0.12.

2059 STOCHASTIC STUDY OF THE HISTORY OF NEUTRONS IN A MODERATOR. G.Louchard.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 46, No. 5, 363-84 (1960). In French.

In continuation of a former paper (Abstr. 20152 of 1960) formal results are presented for the distribution of energies without and with fission. It is shown that results on the distribution of velocities in direction can also be obtained. H.N.V.Temperley

2060 NEUTRON AGE MEASUREMENT IN GRAPHITE IMPREGNATED BY DIPHENYL.
R.Bonalumi, C.Bruschi and G.B.Zorzoli.
Energia nucleare (Italy), Vol. 7, No. 12, 862-4 (Dec., 1960).

The age of fission neutrons in graphite impregnated by diphenyl was measured by means of activation of indium detectors, using a natural uranium disk as a neutron source. The experimental technique is described and the experimental results are discussed.

2061 NEUTRON-ABSORBING BRICKS MADE FROM CaB_6. J.W.Butler.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 201-3 (May, 1960).

A technique is described for making relatively inexpensive neutron-absorbing bricks from commercially available CaB_6 powder. The bricks are 2 in. × 3 in. × 5 in., and are strong enough to withstand normal handling. They last indefinitely; the ones described are now 7 years old, used and stored under normal room temperatures and humidities. The procedure is to make a thick, dry mud with the powder and water, followed by compression in a mould at pressures of about 1 ton/in.^{2} or more. The bricks are then baked for 2 hours or longer at a temperature of about 750° C.

2062 A POLARIZED NEUTRON BEAM PRODUCED BY BRAGG REFLECTION FROM Co–Fe ALLOY.
M.A.Clark and J.M.Robson.
Canad. J. Phys., Vol. 39, No. 1, 1-12 (Jan., 1961).

A single crystal of Co–Fe alloy is being used to produce a diffracted beam of neutrons with a flux of 2.6×10^6 n cm^{-2} sec^{-1} over an area of 1.5 in. by 1.5 in. This beam contains 92 ± 5% first-order neutrons ($\lambda = 1.37$ A, E = 0.0436 eV), 3 ± 5% second- and higher-order neutrons, and 5% incoherently scattered neutrons. The first-order part of the beam has a polarization of 0.98 ± 0.01; the second-order part of the beam has a polarization of 0.36 ± 0.05 the same direction as the first-order part, and the over-all beam has a polarization of 0.92 ± 0.05. The neutron spins can be reversed by the magnetic resonance technique with flipping efficiencies of 98% for the first order and 97% for the over-all beam.

2063 ON THE POLARIZATION OF NEUTRONS FROM MUON CAPTURE BY THE NUCLEUS. W.Majewski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 7, 467-70 (1960).

Examines virtual pion corrections in the V–A theory. Concludes they are small. R.J.N.Phillip

2064 SPACE AND ENERGY SEPARABILITY OF THERMAL FLUX IN A DIFFUSING MEDIUM.
E.M.Gelbard and J.J.Pearson.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 453-5 (Nov., 1959).

Following the doubts expressed about the validity of the assumption of separability in thermal neutron flux calculations, the steady state diffusion of neutrons from a thermal plane source of neutrons in an infinite medium has been measured using light water as the moderator. Different amounts of a v^{-1} absorber were added to the water and it was found that the flux fell off exponentially beyond a transient region and that an asymptotic spectrum was attained. The extent of the transient region was found to depend on the amount of absorption. J.F.Bl

2065 SLOWING DOWN OF NEUTRONS IN A HETEROGENE SYSTEM. G.Blässer.
Nukleonik (Germany), Vol. 2, No. 4, 141-4 (June, 1960). In Germa

A transport equation treatment for neutron slowing down, leading to a relation for resonance capture in heterogeneous syste C.G.Mor

2066 DETERMINATION OF THE ENERGY OF ANTIMONY–BERYLLIUM PHOTONEUTRONS. H.W.Schmitt.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 220-6 (Oct. 4, 1960).

The transmission of a spherical shell of enriched B^{10} was measured and used to determine the average energy of neutrons from a spherical antimony–beryllium source. Analysis of the transmission data in terms of the known absorption and total cross sections of B^{10}, including effects of single and multiple neutron scattering in the shell and source, permits determination of the effective energy of neutrons in the shell, the average energy of neutrons emitted from the particular source, and an estimate of the initial antimony–beryllium photoneutron energy. The average energy of neutrons from the neutron source of this experiment is 24.0 ± 2.2 keV; the initial energy of the primary group of antimony-beryllium photoneutrons is 24.8 ± 2.4 keV. A discussion of the source neutron energy as a function of source dimensions is inclu

2067 HIGH RESOLUTION NEUTRON SPECTROSCOPY. H.W.Newson and R.M.Williamson.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 67-72 (April, 1960).

The current state of high resolution spectroscopy with a Van Graaff accelerator is reviewed. For neutrons in the keV region resolutions of about 3% at 10 keV and 0.7% at 100 keV have been attained. The resolution for 2 MeV protons is about 1.5×10^{-4}; v large ion currents are feasible at this resolution.

2068 NEUTRON TIME-OF-FLIGHT SPECTROMETER. H.Ţoţia, P.Timiş and C.Lazarovici.
Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 1, 89-98 (1959). In Roumanian.

A time analyser for a spectrometer is described. It is base on matrix coincidence and has 64 channels with widths from 2 μs

160 μsec. With the help of delay lines, an interval from 32 μsec 80 μsec can be covered. The recording is done by thyratron-ggered high-speed mechanical counters. D.H.Lord

2069 A "TIME EXPANDER" FOR PRECISION NEUTRON TIME-OF-FLIGHT EXPERIMENTATION. J.R.Waters.
clear Instrum. and Methods (Internat.), Vol. 7, No. 2, 174-8 ay, 1960).

For accurate neutron time-of-flight experiments, narrow timing nnels must be used. These are frequently generated by converting time-of-flight of a neutron into a pulse of proportional amplitude l then performing a pulse height analysis. This converter, and o the one in the pulse height analyser, are subject to drifting intro-cing inaccuracies into the measured data. The instrument described e replaces both of these converters, with one entirely digital stem which is inherently drift free. It uses a scaler to measure number of fast "clock" pulses preceding the arrival of a neutron l then complements this number with slow pulses which are also into the memory and display unit of the original spectrometer. us it allows a spectrometer designed for 2 μsec timing channels to used with 0.25 μsec channels with no internal changes. Improved bility and reliability is obtained by the use of transistors through-.

2070 THE PROBLEM OF MEASURING THE ABSOLUTE YIELD OF 14 MeV NEUTRONS BY MEANS OF AN LPHA COUNTER.
Benveniste, A.C.Mitchell, C.D.Schrader and J.H.Zenger.
clear Instrum. and Methods (Internat.), Vol. 7, No. 3, 306-14 ine, 1960).

The assumptions used to derive the total neutron yield per tected alpha particle (from the D–T reaction) which were derived an earlier report are re-examined in the light of additional experi-ntal information. It is concluded that, for an alpha counter at 90° the incident beam direction, the assumptions introduce practically difficulties. Therefore, for precise monitoring in the absence of rtain target information, it is recommended that this configuration used. For counters at angles different from 90°, nonuniformity target loading contributes the most serious error to the computed ld.

esons

2071 AN INTERPRETATION OF 550 m_e PARTICLES. M.Inoki.
Phys. Soc. Japan, Vol. 14, No. 12, 1832 (Dec., 1959).

It is suggested that the 550 m_e particles, so far undetected t see Abstr. 3411 of 1957), might yet exist, but with a charge $\frac{1}{2}e$. E.W.Kellermann

2072 SEARCH FOR NEUTRINOLESS CONVERSION OF MUON INTO ELECTRON. R.D.Sard, K.M.Crowe and H.Kruger.
ys. Rev. (USA), Vol. 121, No. 2, 619-23 (Jan. 15, 1961).

A search was made for the hypothetical reaction in which a on near a nucleus is converted into an electron without produc-n of neutrinos. Negative muons were stopped in a copper target. nagnetic spectrometer at right angles to the beam transmitted ticles of the momentum expected for the electron (about 90 MeV/c entry into the spectrometer). A long scintillation counter at the put of the spectrometer gave a pulse corresponding to the emer-g particle's energy loss. Selection by both momentum and pulse-ght eliminated particles heavier than the electron and greatly uced the accidental background. In the main run, three events eting the selection criteria were recorded, while the expected nber of accidentals is 0.23 ± 0.04. Various alternative processes l would produced accepted events are considered and found to e expectation values even smaller than that for accidentals. With-further experimentation, one cannot decide whether the hypothe-l reaction does or does not occur, but one can set an upper limit $4_{-3}^{+3}) \times 10^{-6}$ on the ratio, R, of the reaction rate to that of mal absorption.

2073 REACTION $\mu + N \rightarrow e + N'$: INTERMEDIATE BOSON THEORY. F.J.Ernst.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 478-80 (Nov. 15, 1960).

The branching ratio of $\mu + N \rightarrow e + N'$ is calculated on the basis of a μ–e–γ interaction mediated by an intermediate boson. Values are calculated for various cut-off momenta and boson masses. Taking the absence of the real process $\mu \rightarrow e + \gamma$ into account, a branching ratio of order 10^{-6} is found. J.S.Dowker

2074 MUONIUM FORMATION IN SEMICONDUCTORS. G.Feher, R.Prepost and A.M.Sachs.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 515-18 (Dec. 1, 1960).

Measurements were made of the depolarization of positive muons stopping in silicon and germanium, using the standard pre-cession method. The value of the asymmetry parameter a increased from 0.10 for intrinsic silicon to 0.25 as the concentration of holes (boron doping) was increased to 10^{18} cm^{-3}. Increasing the concentration of electrons (phosphorus doping) to a similar level reduced the value of a almost to zero. A sample of N-type germanium ($\sim 10^{15}$ electrons cm^{-3}) showed almost the full value of a (0.33) at room temperature and almost zero at liquid nitrogen temperature. The results are discussed in terms of muonium formation. A.Ashmore

2075 THE ANOMALOUS SCATTERING OF UNDERGROUND μ-MESONS. R.Burnstein, T.Kitamura and D.D.Millar.
Nuclear Phys. (Internat.), Vol. 19, No 6, 665-74 (Dec. (2), 1960).

An experiment is described using a magnet cloud chamber and a multiplate chamber to investigate the scattering of underground μ-mesons of momentum < 1.5 GeV/c in iron and in lead. No evidence has been obtained for or against the existence of anomalous large-angle scattering. A computation of the effects of errors, as determined experimentally, on the theoretical scattering distribution indicates that these could easily simulate an apparent anomaly if not taken into account and that when they are taken into account the possibility of distinguishing between scattering from an extended nucleus and from a point nucleus becomes remote.

THE SCATTERING OF μ-MESONS IN VARIOUS SUBSTANCES. See Abstr. 2124

2076 DEPOLARIZATION OF μ^--MESONS IN NIKFI EMULSIONS SUBJECTED TO A MAGNETIC FIELD OF 10^4 Oe. I.Andreescu, T.Angelescu, C.Besliu, V.Codită, N.Martalogu, V.Pîrvu and N.Gheordănescu.
C.R.Acad. Sci. (France), Vol. 251, No. 15, 1496-8 (Oct. 10, 1960). In French.

Some 6000 events indicated a polarization of 0.38 ± 0.13 before decay compared with 0.34 calculated on the basis of a coupling between the μ^--meson and the electrons of the mesic atom. With a field of only 150 Oe, this polarization was 0.08 ± 0.13. E.J.Burge

2077 π-MESON–ELECTRON SCATTERING AND THE [ELECTROMAGNETIC] STRUCTURE OF THE π-MESON. H.Salecker.
Z. Naturforsch (Germany), Vol. 15a, No. 12, 1023-30 (Dec., 1960). In German.

This experiment requires very high energy, but not necessarily such a high accuracy as the extrapolation procedure of Chew and Low. After a short discussion of the general properties of the electromagnetic form factor of the π-meson, a calculation is made of the π–e and the e–π scattering cross-sections with form factor. With an energy of 25 GeV and a 10% experimental error, one can investigate the root mean square radius of the pion down to 0.8×10^{-13} cm, with 50 GeV down to 0.6×10^{-13} cm and with 100 GeV to 0.36×10^{-13} cm. The r.m.s. radius of the pion may be larger than previously assumed, because there exists the possibility of a fairly large π–π interaction. A complementary possibility for investigating the electromagnetic structure of the pion is electron–positron pair annihilation with the creation of a $\pi^{\pm}$-pair. This process will facilitate the study of the form factor of the π-meson for time-like arguments.

2078 EFFECT OF LEPTON NON-CONSERVATION ON π-DECAY. P.K.Kabir.
Nuovo Cimento (Italy), Vol. 17, No. 3, 438-41 (Aug. 1, 1960).

It is claimed that the agreement of the observed branching ratio

of $\pi-e$ to $\pi-\mu$ decays with the prediction of Ruderman and Finkelstein (Abstr. 2685 of 1950) indicates that the admixture of lepton-nonconserving A interaction must be exceedingly small or non-existent. [An error in the calculation invalidates this result, and no definite conclusion may be drawn regarding such an admixture. See correction: Ibid., No. 6, 991 (Sept. 16, 1960)]. P.K.Kabir

2079 LIFETIME OF THE NEUTRAL PION.
V.Glaser and R.A.Ferrell.
Phys. Rev. (USA), Vol. 121, No. 3, 886-92 (Feb. 1, 1961).

As Primakoff has noted (Abstr. 4754 of 1951), the phenomenological coupling constant of the neutral pion with the electromagnetic field can be investigated by considering the photoproduction of neutral pions in an external Coulomb field. This is the inverse of the usual two-photon decay (one of the photons being provided by the external field). The relationship between the cross-section and the free lifetime of the π^0 is derived. Although the total cross-section is small, it is found at high energy that the differential cross-section is strongly peaked near the forward direction. The peak cross-section is proportional to the fourth power of the photon energy. It is this feature which makes possible an experimental determination of the lifetime by the photoproduction method to an accuracy of ~10%. A minimum photon energy of 1 GeV is required to avoid uncertainties in the nuclear form factor. A higher photon energy would be necessary only if the π^0 mean life is greater than 5×10^{-17} sec. The backgrounds to be expected from nuclear photoproduction are estimated and found to be sufficiently small. In particular, the interference between the coherent nuclear π^0 photoproduction and the Primakoff process is not excessive.

2080 $\pi\pi$ INTERACTION ON PERIPHERAL πN COLLISIONS.
D.I.Blohinčev.
Nuovo Cimento (Italy), Vol. 18, No. 1, 193-4 (Oct. 1, 1960).

The contribution of $\pi\pi$ interaction to inelastic πN scattering is estimated by applying a nucleon model described earlier (Abstr. 9946 of 1959). Comparison with recent experimental data for 7 GeV pions yields a value for $\sigma_{\pi\pi}$ of 50 mb (with a statistical error of ± 100%). P.K.Kabir

2081 A NOTE ON $\pi-\pi$ INTERACTION.
A.N.Mitra, R.P.Saxena and P.Narayanaswamy.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 491-8 (Nov. (2), 1960).

Some qualitative aspects of the $\pi-\pi$ interaction were studied with the help of a simple model which incorporates the essential features of the Bethe–Salpeter integral equation for $\pi-\pi$ interaction, obtained by the authors some time ago. It is found (i) that a contact type ϕ^4 term does not affect the nature of the interaction which is attractive, and (ii) that the energy at which a resonance occurs increases with the effective $\pi-\pi$ coupling parameter. The numerical solutions of the $\pi-\pi$ equations derived by Mitra and Saxena (Abstr. 7269 of 1958) agree qualitatively with these predictions, and suggest that the I = 0 interaction (which has a larger coupling parameter) gives a resonance at a much higher energy than I = 2.

2082 INELASTIC INTERACTIONS OF π-MESONS WITH NUCLEONS AT 6.8 GeV. V.S.Barashenkov.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 71-7 (Jan., 1961).

The results of experiments with π-mesons are compared with the calculations by the statistical theory. Good agreement is observed in the distribution of stars with given number of prongs and momentum of the particles produced. Peripheral collisions are taken into account to explain angular distributions. Experimental data can be brought into agreement with the theory under the assumption that the cross-section of peripheral collisions accounts for more than a half of the total cross-section of all inelastic processes. The resonant interaction of π-mesons is discussed.

2083 FORMATION OF CHARGED MESONS BY 245 MeV π-MESONS ON HYDROGEN.
Yu.A.Batusov, S.A.Bunyatov, V.M.Sidorov and V.A.Yarba.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6(12), 1850-2 (Dec., 1960). In Russian.

Preliminary results obtained in studying the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ are presented. So far, only 32 events have been found. The cross-section of the reaction and the momentum and angular distributions of the secondary particles are shown [English translation in: Soviet Physics–JETP (USA)]. F.Herbut

2084 ON THE POSSIBILITY OF MEASURING THE BRANCHING RATIO $R = \frac{(\pi^- + p \rightarrow \pi^0 + \pi^- + p)}{(\pi^- + p \rightarrow \pi^+ + \pi^- + n)}$ AT VERY HIGH ENERGIES. A.Krzywicki.
Bull. Acad. Polon, Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 7. 477-85 (1960).

Argues that, for suitable particle momenta, this ratio can be inferred from experiments in which the neutral particles are not detected. R.J.N.Phillips

2085 HIGH-ENERGY PION–NUCLEON COLLISIONS AND ISOTOPIC PROPERTIES OF THE PION–PION INTERACTION. A.Krzywicki.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 7, 487-91 (1960).

Relates the branching ratio considered earlier (see preceding abstract) to the isotopic spin dependence of the $\pi-\pi$ interaction. Also suggests an experiment to check the arguments of the previous paper. R.J.N.Phillips

2086 CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS BY HYDROGEN AT 230, 260, 290, 317, AND 371 MeV.
J.C.Caris, R.W.Kenney, V.Perez-Mendes and W.A.Perkins, III.
Phys. Rev. (USA), Vol. 121, No. 3, 893-904 (Feb. 1, 1961).

The differential cross-section was observed at 230, 260, 290, 317, and 371 MeV. The reaction was observed by detecting one gamma ray from the π^0 decay with a scintillation-counter telescope. A least squares analysis was performed to fit the observations to the function

$$\frac{d\sigma}{d\omega} = \sum_{l=1}^{8} a_l P_{l-1}(\cos\theta)$$

in the c.m. frame. The best fit to the experimental measurements requires only s- and p-wave scattering. The results (in mb) are:

E (MeV)	a_1	a_2	a_3
230 ± 8	2.50 ± 0.10	1.39 ± 0.15	2.73 ± 0.28
260 ± 7	2.02 ± 0.08	1.75 ± 0.14	2.15 ± 0.22
290 ± 9	1.45 ± 0.06	1.80 ± 0.10	1.89 ± 0.18
317 ± 8	1.40 ± 0.06	1.85 ± 0.10	1.50 ± 0.17
371 ± 9	1.08 ± 0.05	1.63 ± 0.08	1.18 ± 0.12

The least-squares analysis indicates that d-wave scattering is not established in this energy range.

2087 SHADOW EFFECT IN THE SCATTERING OF GeV PIONS AND NUCLEONS BY DEUTERONS.
B.Dejon and K.Smith.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 346-8 (Sept., 1960).

The experimental total cross-sections for the individual pion-nucleon and nucleon–nucleon processes were used to deduce the pion–deuteron and nucleon–deuteron total cross-sections using a geometrical optic model

2088 $\pi-\pi$ SCATTERING, NUCLEON STRUCTURE AND $\pi-N$ SCATTERING.
J.Bowcock, W.N.Cottingham and D.Lurié.
Phys. Rev. Letters (USA), Vol. 5, No. 8, 386-90 (Oct. 15, 1960).

The reasons for the failure of Frautschi (Abstr. 17387 of 1960) to explain the $\pi-N$ scattering lengths are examined. It is shown that the difficulty arises from the use of integrals which cannot be reliably evaluated, and an inappropriate choice of the resonance energy. A suitable choice of the resonance parameters for the J = T = 1 state gives "very satisfactory agreement" with the existing experimental data on the isovector form factors and the $\pi-N$ phase shifts. P.K.Kabir

2089 POSITION OF THE NEAREST $\pi\pi$-SCATTERING AMPLITUDE SINGULARITIES.
V.A.Kolkunov, L.B.Okun, A.P.Rudik, and V.V.Sudakov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 340-4 (Aug., 1960). In Russian.

A number of $\pi\pi$-scattering diagrams are considered for which the so-called singular curves (threshold of the appearance of the imaginary part of the amplitude) possess asymptotic values equal to 16 μ^2. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 2, 242-4 (Feb., 1961)].

2090 CALCULATION OF THE PION–NUCLEON SCATTERING PHASES FROM DISPERSION RELATIONS. I.
hler and K.Dietz.
hys. (Germany), Vol. 160, No. 4, 453-72 (1960). In German.
The real part of the s-wave amplitude is calculated by replacing lispersion integral by the contribution of the 33 resonance, as in vork of Chew et al. (Abstr. 7428 of 1957) but without the approxtions made by these authors in the treatment of the nucleon il and of the s-wave projection. The effect of these approximas is significant. A correction for the neglected part of the dision integral is obtained by adding its value at zero kinetic gy, calculated from the total cross-sections. The results agree with experiment up to 333 MeV. The p-wave scattering lengths calculated similarly. Some discussion of the effect of a pion– interaction is given. E.J.Squires

2091 A MODEL FOR MULTIPLE MESON PRODUCTION WITH FINITE N–π AND π–π INTERACTION.
Bubelev.
nic Ray Conference, Moscow, 1959, English Edition, (see r. 7427 of 1960) Vol. I, p. 285-9.
A model of multiple production of mesons resulting from nsive interaction of the mesonic field of colliding nucleons is ribed. The assumption regarding the finiteness of such an raction allows an interpretation of both the "two-centres" jets rved at energies greater than 10^{12} eV and also of "one-centre" recorded at energies of about 10^{11} eV. C.F.Barnaby

2092 DOUBLE PION PHOTOPRODUCTION.
M.Feldman, V.Highland, J.W.DeWire and R.M.Littaver.
s. Rev. Letters (USA), Vol. 5, No. 9, 435-7 (Nov. 1, 1960).
Measurements are reported on the double pion photoproduction tions $\gamma + p \rightarrow p + \pi^0 + \pi^0$ and $\gamma + p \rightarrow n + \pi^+ + \pi^0$ for photon ener- in the interval 930-1200 MeV. The measurements were made bserving the two π's in coincidence. The results are tabulated ngles of the pions ranging from 50^0-120^0 (lab). The results are pared with phase space predictions. R.F.Peierls

2093 PHOTOPRODUCTION OF NEGATIVE PIONS FROM HYDROGEN AT FORWARD ANGLES.
Kilner, R.E.Diebold and R.L.Walker.
s. Rev. Letters (USA), Vol. 5, No. 11, 518-20 (Dec. 1, 1960).
The bremsstrahlung beam from a synchrotron was used to uce negative pions in a liquid hydrogen target predominantly ugh the process $\gamma + p \rightarrow \pi^- + \pi^+ + p$. A "synchrotron subtraction" performed to determine the energy, k, of the photon initiating reaction and the negative pions were analysed with a wedge-type netic spectrometer and detected with a counter telescope system. were taken at laboratory angles ranging from 5^0-30^0 and at π^- ratory momenta of ~ 600-1000 MeV/c. Curves are given for: (θ, ω), for k = 1230 MeV as a function of π^- centre-of-momentum energy (and also of Q) for several angles; (2) the angular distion for the average value of the data points at ω = 464, 505, and MeV. Qualitatively, the results agree with Drell's model ugh the experimental cross-sections are, in general, considerlarger. J.H.Gunn

2094 DECAY PROPERTIES OF HEAVY MESONS AND HYPERONS. É.O.Okonov.
khi fiz. Nauk (USSR), Vol. 67, No. 2, 245-91 (Feb., 1959). In ian. English translation in: Soviet Physics–Uspekhi (USA), 2(67), No. 1, 119-49 (Jan.-Feb., 1959).
review (at February 1959) of work on strange-particle physics the previous two years. It includes a discussion of the various les describing possible new particles and anomalous decays, n are less well established. There is an extensive bibliography. S.J.Goldsack

2095 CONSISTENCY OF THE $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$ RATE WITH THE $\Delta T = \frac{1}{2}$ RULE. N.Cabibbo and R.Gatto.
. Rev. Letters (USA), Vol. 5, No. 8, 382-4 (Oct. 15, 1960).
On the basis of a certain model for $K \rightarrow 2\pi$ decays, it is shown he total amplitude for the radiative process is not expected to uch larger than the internal bremsstrahlung contribution. P.K.Kabir

2096 PARTIALLY CONSERVED CURRENTS AND THE K' MESON. J.Bernstein and S.Weinberg.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 481-3 (Nov. 15, 1960).
The effect of the conjectured K–π resonance on the $\Delta S = 1$ leptonic decay processes, $K_{\mu 3}$ and K_{e3}, is considered. A dispersion relation technique is employed, the K–π resonance being assumed to dominate all dispersion integrals and to be represented by a pole. J.S.Dowker

2097 PRELIMINARY RESULTS ON THE INTERACTIONS IN PHOTOGRAPHIC EMULSION OF K^- MESONS AT 1.15 GeV/c.
L.Culhane, D.Keefe, A.Kernan, J.Losty and A.Montwill.
Nuovo Cimento (Italy), Vol. 16, No. 5, 1135-8 (June 16, 1960).
With a 4.5 μ^-: 1.5 K^-: 0.25 π^- particle mixture in the beam an interaction mean free path of 59 ± 5 cm was found, giving a mean free path for K^- mesons in emulsion as 17 ± 2 cm. The prong number distributions were studied and a lower limit of 22% was obtained for strange-particle production. S.J St-Lorant

2098 K^-p SCATTERING AND $K^- + p \rightarrow Y^- + \pi$ REACTIONS.
J.Szymański.
Bull Acad. Polon. Sci. Ser Sci. math. astron. phys. (Poland), Vol. 7, No. 7, 435-40 (1959).
A calculation of cross-sections based on the fixed-source approximation and assuming scalar K-baryon coupling, the computations being carried out by the Tamm–Dankoff method. The results are not in very good agreement with experiment. Possible reasons are discussed. S.J.Goldsack

Hyperons

2099 PARITY NON-CONSERVATION IN STRONG INTERACTIONS INVOLVING STRANGE PARTICLES.
Van Gan-chan [Wang Kang-ch'ang], Van Tsu-tszen [Wang T'su-tsêng], V.I.Veksler, I.Vrana, Din Da-tsao [Ting Ta-ts'ao], V.G.Ivanov, Kim Khi In, E.N.Kladnitskaya, A.A.Kuznetsov, Nguen Din Ty, A.V.Nikitin, M.I.Solov'iev, T.Khofmokl' and Chen Lin-yan' [Ch'ên Ling-yen].
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 6(12) 1854-6 (Dec., 1960). In Russian.
A preliminary analysis of the angular asymmetries in the decays of Λ-particles produced in π–p collisions is presented. No right–left or up–down asymmetries were found. Some forward–backward asymmetry was observed indicating parity non-conservation in the associated production of Λ-particles but this may be due to insufficient statistics. [English translation in: Soviet Physics-JETP (USA)]. J.S.Dowker

Deuterons

2100 CALCULATION OF THE DEUTERON GROUND STATE WITH SPHERICAL SYMMETRY. C.Deutsch.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1459-61 (Oct. 10, 1960). In French.
Purports to derive the binding energy and other properties from the electrostatic interaction of two protons and a π^- meson. R.J.N.Phillips

2101 RELATIVISTIC CALCULATION OF THE DEUTERON GROUND STATE. C.Deutsch.
C.R. Acad. Sci. (France), Vol. 251, No. 16, 1609-11 (Oct. 17, 1960). In French.
Calculates the internucleon potential to lowest order in fixed-source charged scalar meson field theory, with apparent disregard for charge conservation. Regards this as the binding energy. R.J.N.Phillips

2102 PHOTODISINTEGRATION OF THE DEUTERON FROM 500 TO 900 MeV.
H.Myers, R.Gomez, D.Guinier and A.V.Tollestrup.
Phys. Rev. (USA), Vol. 121, No. 2, 630-5 (Jan. 15, 1961).

The reaction $\gamma + d \rightarrow p + n$ was studied for photon energies between 500 and 900 MeV. Bremsstrahlung from an electron synchrotron was incident on a liquid deuterium target. Measurements of the energy and angle of the protons arising in the interactions were sufficient to establish that photodisintegration without pion emission occurred and also to determine the energy of the photon which gave rise to the detected proton. An excitation curve was obtained at 90° in the laboratory and angular distributions were measured for photon energies of 500 and 700 MeV. The total cross-section decreased smoothly from 7 μb at 500 MeV to 1 μb at 900 MeV.

2103 P-WAVE PHASE SHIFTS AT 210 MeV AND THE PHOTODISINTEGRATION OF THE DEUTERON.
G.Kramer.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 439-41 (Nov. 1, 1960).

The cross-section for photodisintegration of the deuteron is calculated at a γ-ray energy corresponding to a final nucleon—nucleon energy of 210 MeV, using the four sets of nucleon—nucleon phase shifts found by MacGregor and Moravcsik (Abstr. 12931 of 1960) at this energy. The resulting angular distribution agrees reasonably with experiment only for solution B, which is also favoured by other considerations. E.J.Squires

Tritons

2104 THREE-BODY NUCLEAR PROBLEM WITH REPULSIVE CORE FORCES. C.Werntz.
Phys. Rev. (USA), Vol. 121, No. 3, 849-853 (Feb. 1, 1961).

A variational calculation of the binding energy of the triton was carried out using the Gartenhaus potential (Abstr. 921 of 1956). The results indicate that this potential leads to an unbound ground state of the three-nucleon system; this result is attributable to the even-parity tensor potential which is relatively large in magnitude compared to the weakly attractive even-parity central potential. Since this property is also a characteristic of the Signell—Marshak potential (Abstr. 2468 of 1958), it too should lead to an unbound triton.

Alpha-particles

2105 EFFECT OF THE FINITE SIZE OF THE PROTON ON THE COULOMB ENERGY OF THE He^3. T.Ohmura.
Progr. theor. Phys. (Japan), Vol. 22, No. 1, 148-50 (July, 1959).

This effect is estimated and found to reduce the Coulomb energy appreciably. The implications of this result are discussed in connection with a comparison of the binding energies of He^3 and H^3, with respect to the charge-symmetry of nuclear forces. P.K.Kabir

2106 INELASTIC SCATTERING OF ELECTRONS FROM He^4. G.R.Burleson.
Phys. Rev. (USA), Vol. 121, No. 2, 624-30 (Jan. 15, 1961).

The inelastic scattering of electrons from He^4, which corresponds to a disintegration of the nucleus, was studied for incident electron energies of 400 and 500 MeV at laboratory angles from 45° to 135°. The energy spectra of the scattered electrons were measured, and absolute cross-sections were found by comparison with elastic scattering from hydrogen. The curves were corrected for electron radiation. Within the validity of adapting to He^4 one of the results of the Goldberg theory of deuteron electrodisintegration, (Abstr. 4898 of 1959), the cross-sections at the maxima of the curves give a value of $M\langle 1/p\rangle_\alpha$ of (7.5 ± 1.5), where M is a nucleon mass and $\langle 1/p\rangle_\alpha$ is the expectation value of the reciprocal of the momentum of a nucleon bound in He^4. With a single exception, the energy-integrated cross-sections $d\sigma/d\Omega$ agree within experimental error with $d\sigma_\alpha/d\Omega = 2(d\sigma_p/d\Omega + d\sigma_n/d\Omega)$, where $d\sigma_p/d\Omega$ is the free-proton cross-section and $d\sigma_n/d\Omega$ is the neutron cross-section found from inelastic scattering from deuterium.

2107 ELASTIC SCATTERING OF ALPHA PARTICLES FROM HELIUM. J.R.Dunning, A.M.Smith and F.E.Steigert.
Phys. Rev. (USA), Vol. 121, No. 2, 580-3 (Jan. 15, 1961).

The elastic scattering was investigated at laboratory energies of 6.43, 6.84, and 7.78 MeV. Complete angular distributions from 20° to 90° in the centre-of-mass system were obtained. Analysis of the data suggests somewhat smaller values for the D-wave phase shift than previously reported.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

2108 INTERNATIONAL COSMIC-RAY CONFERENCE. N.A.Dobrotin.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 4, 679-91 (Dec., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 974-86 (June, 1960).
See Abstr. 7427 of 1960.

GEOMAGNETIC, AURORAL, IONOSPHERIC AND COSMIC RAY PERTURBATIONS: THEIR INTERDEPENDENCE AND RELATION TO SOLAR ACTIVITY. See Abstr. 1524

CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY, SOLAR PHENOMENA AND OTHER RELATED PHENOMENA.
See Abstr. 21343 of 1960.

2109 APPLICATIONS OF LARGE SCINTILLATION DETECTORS TO COSMIC RAY EXPERIMENTS.
G.W.Clark.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 164-9 (July-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium. Washington, February, 1960].

Large scintillation detectors were employed in several areas of cosmic ray investigation including air shower studies, μ-meson polarization measurements, μ-meson intensity monitoring, and a search for cosmic γ-rays. The general principles of the design of large detectors are discussed. Descriptions are given of the construction and performances of several detectors with sensitive areas as large as 3.6 m^2.

2110 PROCESSES INVOLVED IN ELECTROMAGNETIC ACCELERATION OF PARTICLES TO COSMIC-RAY ENERGIES. W.F.G.Swann.
J. Franklin Inst.(USA), Vol. 270, No. 5, 343-52 (Nov., 1960).

Extends the author's earlier work, according to which charged particles could be accelerated to cosmic-ray energies through electromagnetic induction resulting from magnetic fields like those encountered in sunspots. The paper confines itself, for simplicity, to cases of axial symmetry, and in particular to cases where U_θ is of the form $U_\theta = 10^{12}(r_0/r)^n F(t)$, where r is the distance from the axis of symmetry, U_θ is the vector potential, which lies in planes perpendicular to that axis, and has no radial or z component. F(t) is a function of time which rises from zero at t = 0 to a peak value of unity, and then decays to zero. The above expression for U_θ corresponds to a maximum average magnetic flux of 2000 G within the radius r_0 which is taken as 10^9 cm. Protons which start from rest at t = 0 are considered. When $\partial U_\theta/\partial r$ is zero, corresponding to n = 0, the particles describe circles. This is a good condition for the acquirement of high energies and yields an energy of 3×10^{14} eV by the time F(t) has attained the peak value. However, the particles remain in their circular orbits during the deceleration period following the attainment of the peak value unless they are scattered out of them by some scattering mechanism; and they lose all their energy by the time F(t) has diminished to zero. If $\partial U_\theta/\partial r$ is negative (that is, if n is positive) the particles spiral outwards, while if it is positive (that is, if n is negative) they spiral inwards. However, if n is appreciably different from zero in the positive sense, the particles spiral outwards so rapidly to the realms where the acceleration process is weak that the total energy acquired in spiralling out to infinity is small. However, in order to realize an essentially circular orbit, it is not necessary to have a field for

ich $\partial U_\theta/\partial r$ is zero at all points. In fact, if the curve of U_θ plotted ainst r shows, at some value of r, a sharp descent followed by a arp rise and by a subsequent slow descent, one has a sort of ough in the U_θ versus r curve. In this trough, there is a place ere $\partial U_\theta/\partial r$ is zero, and particles can describe essentially stable rcular orbits in this trough and can become accelerated to high ergies. If during the period of the rise of F(t), which in practice of the order 10^8 sec, the trough disappears, the particles will oceed to spiral out to infinity, but without parting with the energy ey have attained while in the trough. [A shorter version of this per was presented at the Moscow Cosmic Ray Conference — e Abstr. 7427 of 1960].

2111 THE FRAGMENTATION PROBABILITIES OF FAST HEAVY COSMIC-RAY PRIMARIES IN TEFLON.
A.Brisbout, C.F.Gauld and C.B.A.McCusker.
ovo Cimento (Italy), Vol. 18, No. 2, 400-2 (Oct. 16, 1960).

A sandwich stack of nuclear emulsions and Teflon $(C_2F_4)_n$ eets was exposed, and the fragmentations occurring in nuclear ulsions were compared with those in Teflon whose average Z is ose to that of the atmosphere. The results seem to agree with ose of other workers, justifying the use of Teflon.

E.W.Kellermann

2112 SHORT-PERIOD TIME VARIATIONS OF EXTENSIVE COSMIC RAY SHOWERS.
G.Yerg and P.M.Gildersleeve.
ature (GB), Vol. 188, 651-2 (Nov. 19, 1960).

An explanatory experiment is described to determine whether ort-period fluctuations in the arrival of extensive showers are fficiently systematic to warrant detailed study. The results ggest that long time-intervals between successive counts tended be followed by long intervals approximately 4-9 counts later. ie average time interval between counts was 74 sec, so that a stematic variation in the arrival of extensive air showers was dicated in the range of 5-11 min. The apparatus consisted of two iger counters operated in coincidence and placed parallel and n apart horizontally on the roof of a building free from structions. C.F.Barnaby

2113 FLUCTUATION PROBLEM IN ELECTROMAGNETIC CASCADES. S.K.Srinivasan.
Phys. (Germany), Vol. 161, No. 3, 346-52 (1961).

Examined in the light of the new approach to cascade theory; s shown that the method originally proposed by Janossy ostr. 4336 of 1950) is best suited to deal with this problem. A thod of obtaining explicit expressions for the second moment of distribution is given and the differential equations obtained by s method turn out to be simpler and amenable to numerical nputation.

2114 SOLAR-PRODUCED COSMIC RADIATION NEAR THE GEOMAGNETIC POLE ON MAY 4th 1960.
A.Pomerantz and V.R.Pontis.
Franklin Inst. (USA), Vol. 270, No. 3, 227-31 (Sept., 1960).

A sudden increase of the cosmic ray neutron intensity following olar flare was observed at Thule (geomagnetic latitude 88°N) on y 4th 1960. A maximum of 2.33 times the average neutron flux s recorded between 10.42 and 10.48 hr U.T. Details of this event presented and are compared with cosmic ray observations at er stations and with related ionospheric data following the solar e. E.G.Michaelis

2115 DIRECTIONAL DEPENDENCE OF ATMOSPHERIC TEMPERATURE EFFECTS ON COSMIC-RAY MUONS SEA-LEVEL. K.Maeda.
tmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 184-245 (Dec., 1960).

The coefficient of atmospheric temperature effects on the hard nponent of cosmic ray at sea level is derived as a function of the -off energy and the aperture of the measuring instrument and of atmospheric depth of reference level. The derivation of these fficients is primarily based upon the solutions of diffusion ations for cosmic-ray mesons in the standard atmosphere, ing the curvature of isobar levels into account. Secondly, the uence of geomagnetic deflection of muons in the atmosphere is considered. The main feature of these coefficients is erally in agreement with Dorman's results, except for large ith angle. Among the results, the following points are to be noted: (i) There is a direction of maximum negative temperature effect around the zenith angle of 75°, which shifts slightly towards larger angle for higher energy and decreases with the height of reference level. (ii) The coefficient of total effect (positive and negative temperature effects) for small zenith angle is nearly constant against atmospheric depth. (iii) Influence of geomagnetic deflection of muons upon the positive temperature effect is negligible even at the geomagnetic equator, but it is not negligible for the negative effect; the absolute value of the coefficient becomes larger for positive muons than for negative muons arriving from the east direction, and the change is reversed for the muons from west. (iv) Contribution of cosmic ray K-mesons to the atmospheric effect is to suppress the increase of positive temperature coefficient with increase of energy, but the effect seems undetectable due to the existence of an upper limit of magnitude of this effect.

2116 HIGH STABILITY ELECTRONIC EQUIPMENT FOR REGISTERING THE NUCLEON COMPONENT OF COSMIC RAYS. W.Lotz and A.Sittkus.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 237-44 (June, 1960). In German.

A description is given of a full set of electronic instruments for a Neutron Intensity Monitor. The obtained stability in time for 10^4 hr amounts to 6% for the sensitivity of the amplifier and discriminator; 2% for the dead time; 0.5% for 300 V d.c., 0.25% for high voltage. The probable error of the annual mean of the neutron intensity may be reduced to 0.1%. A ratemeter with logarithmic scale has been constructed by using a voltage dependent resistor.

2117 A NON LOCAL FIELD THEORY OF HIGH ENERGY JET. G.Wataghin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 231-3.

Outlines the simple application of a non-local field theory with non-local interactions for the description of a high energy collision. The theory uses the formalism of the S-matrix and satisfies the conditions of relativistic invariance and macroscopic causality. C. F.Barnaby

2118 COMPARISON BETWEEN HYDRODYNAMICAL MODEL AND FIRE-BALL MODEL IN MULTIPLE PRODUCTION OF PARTICLES. S.Ishida, C.Iso and M.Sato.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. I, p. 244-8.

The two-centre (or fireball) Model of nucleon–nucleon collisions at very high energies is compared with the hydrodynamical model, with particular reference to the longitudinal momentum spectrum and the F-plot. C.F.Barnaby

MULTIPLE MESON PRODUCTION WITH FINITE N–π AND π–π INTERACTION. See Abstr. 2091

2119 IMPLICATIONS OF THE HIGH-ENERGY MESON SPECTRUM AND PLUS–MINUS RATIO.
J.Pine, R.J.Davisson and K.Greison.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. I, p. 295-300.

A magnetic spectrometer was used to measure the momentum spectrum and positive excess of cosmic-ray muons in the vertical direction near sea-level. For energies up to 30 BeV, the magnetic deflections were measured with Geiger counter trays; for higher energies, the deflections were measured with three shallow cloud chambers. The maximum measurable momentum was 175 BeV/C. The measured differential momentum spectrum for combined positive and negative mesons is given, and the results compared with those of other workers. The absolute pion momentum spectrum, computed from the muon spectrum, is discussed. The relative positive excess is calculated and these results are also compared with earlier ones. C.F.Barnaby

2120 THE SYDNEY COSMIC RAY SPECTROMETER. H.S.Murdoch, K.W.Ogilvie and H.D.Rathgeber.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. I, p. 304-9.

The instrument, which is described in some detail, was designed to give absolute rates and to allow measurements of the momenta of two or three particles simultaneously passing through it. The first

results obtained with the spectrometer, installed under 7000 gm/cm^2 of rock, are given. It is pointed out that the comparison of the underground results obtained with this instrument with the sea-level μ-meson spectrum should allow a check to be made of energy-loss calculations. C.F.Barnaby

2121 ON HIGH ENERGY μ-MESON SHOWERS. A.A.Yemelyanov and I.J.Rosenthal.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. I, p. 310-16.

The origin of the recently observed high-energy μ-meson showers is discussed on the basis of the calculations of the lateral distribution of high-energy μ-mesons in the hydrodynamical model. C.F.Barnaby

2122 THE POLARIZATION OF COSMIC-RAY MUONS. C.S.Johnson,
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p. 320-3.

A measurement was made of the degree of polarization of positive muons arriving vertically at sea-level. The momentum band investigated was 540 to 593 MeV/c. The polarization was calculated from the asymmetry of the decay-positron angular distribution when the mesons decayed in copper. The upward and downward positron ratio obtained was 1.14 ± 0.02. The average muon polarization at production is calculated to be $0.31^{+0.13}_{-0.06}$. The large error results from the uncertainty in the depolarization correction. It is hoped to evaluate this connection more precisely in the near future and to obtain the value of the polarization to within 10%. C.F.Barnaby

2123 HIGH ENERGY μ-MESONS. I.S.Alexeyev and G.T.Zatsepin.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. I, p.324-6.

The energy spectrum of μ-mesons is a major factor in ascertaining the role of the various processes involved in the generation of high-energy μ-mesons. This spectrum can be calculated by solving a diffusion equation, provided that the probabilities of the elementary processes of μ-meson energy-loss are known. The calculations of these probabilities are discussed in some detail. C.F.Barnaby

2124 THE SCATTERING OF μ-MESONS IN VARIOUS SUBSTANCES. A.I.Alikhanyan.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. I, p. 327-30.

The scattering was measured in lead, beryllium, iron and copper plates, using a counter-controlled cloud chamber at sea-level at Moscow, and a multiplate cloud chamber at an altitude of 960 m. The results obtained for lead agree well with the curve for multiple scattering for finite nuclei, but differs from the curve for point nuclei. The data on μ-meson scattering in Be, Fe and Cu plates agree well with the scattering curves for point nuclei. It is pointed out that if an anomaly exists in μ-meson scattering for the values of momenta studied (up to 2×10^8 eV/c) it is many times less than that observed by other workers and cannot exceed a magnitude of 10^{-28} cm^2/nucleon. Possible reasons for results showing anomalous scattering are given. C.F.Barnaby

2125 THE TOKYO AIR SHOWER EQUIPMENT. Fukui, Hasegawa, Matano, Miura, Oda, Ogita, Suga, Tanahashi, and Tanaka.
Cosmic Ray Conference, Moscow, 1959, English Edition, (see Abstr. 7427 of 1960) Vol. II, p. 30-43.

Preliminary results are given of experiments carried out at Tokyo on extensive air showers. Information was obtained about fluctuations of the shape of the lateral distribution of particle density; the significance and possible explanations of these fluctuations are discussed. C.F.Barnaby

2126 ON EXTENSIVE AIR SHOWERS AT 2770 m ABOVE SEA-LEVEL. T.Kameda, T.Maeda and Y.Toyada.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 58-66.

Experiments are described which were designed to investigate in detail the high-energy electronic component near the shower axis. Results are given of the lateral distribution and energy spectrum of this electronic component, and of the ratio of high-energy electrons and photons to the total number of electrons. For distances from the axis of less than 3.5 m, between 3.5 and 6.5 m, and between 6.5 and 10 m, the spectra obtained were given by $E^{-0.76 \pm 0.06}$, $E^{-1.00 \pm 0.06}$ and $E^{-1.23 \pm 0.08}$, respectively, for the energy range from 250 MeV to 1 BeV. Above 1 BeV, the spectrum gets even steeper. The energy flux of the electronic component and the lateral distribution of charged particles near the shower axis are also discussed. C.F.Barnaby

2127 AN AIR SHOWER EXPERIMENT AT MT. NORIKURA. S.Miyake, K.Hinotani, I.Katsumata and T.Kaneko.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 67-8.

Comprises a multiplate cloud chamber ($2.0 \times 1.3 \times 0.9$ m^3) surrounded by 10 plastic scintillation counters (50 cm^2) and 4 BF_3 neutron counters. Air showers are detected when their densities are greater than 200 particles/m^2. It is installed at Mt. Norikura at an altitude of 2770 m above sea level. The main objective of the experiment is a study of fluctuations and the mechanism of high-energy interactions. C.F.Barnaby

2128 INVESTIGATING CORES OF INDIVIDUAL AIR SHOWERS. N.N.Goryunov, A.D.Erlykin, G.T.Zatespin and A.B.Kamnev.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 70-8.

An experiment is described using 124 ionization chambers arrayed in two trays for the investigation of air shower cores. Results are given of the following characteristics of the shower cores selected for measurement: relationship between the shower particle number and the energy flux of the electron–photon component in the core; core structure of large showers; lateral distribution of energy fluxes of the electron–photon component near the shower core; lateral distribution of energy fluxes of the nuclear-active component in the shower core; lateral distribution of high-energy nuclear-active particles in the shower core; and the energy spectra of nuclear-active particles in the central regions of showers with different size. A comparison is made between the observed energy fluxes of the electron–photon component in the shower cores with those calculated from the electromagnetic cascade theory. C.F.Barnaby

2129 STUDY OF THE ELECTRON–PHOTON COMPONENT OF EXTENSIVE AIR SHOWERS NEAR THE SHOWER AXIS. O.I.Dovženko, S.I.Nikolsky and I.V.Rakobolskaja.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 122-8.

A cloud chamber containing lead plates was used during the autumn of 1955 in the Pamirs at an altitude of 3860 m, and during 1957-8 at Moscow at sea-level. Three hundred showers with a particle number 10^5 were recorded at Pamirs; at Moscow, 2370 showers of 8×10^3 particles, 1830 showers of 1.2×10^4 particles and 436 showers of 3×10^4 particles were registered. The integral energy spectra of the electron–photon components is given. The spectra are of the form $N(\geq E) = \text{constant} \times E^{-\gamma}$. In the energy range from 2×10^8 to 10^9 eV, $\gamma = 0.65 \pm 0.05$ and in range from 2×10^9 to 10^{10} eV, $\gamma = 1.8 \pm 0.2$. From the energy spectra the fractions of the total number of particles in an extensive air shower that constitute electrons and photons of high energy were calculated for various shower sizes. The results obtained showed that, within experimental error, this fraction was not dependent on the shower size. The lateral distribution of the electrons and photons of energy greater than 10^9 eV, and the density of the electron–photon flux in the shower cores are discussed. The experimental results are compared with those predicted by the electromagnetic cascade theory. C.F.Barnaby

2130 STUDY OF THE ENERGY SPECTRUM OF EXTENSIVE AIR SHOWER PENETRATING COMPONENT. E.L.Andronikashvili and R.E.Kasarov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 149-51.

The absorption of shower μ-mesons at various depths under the ground was investigated. Energy spectra were obtained for showers containing 2.9×10^5, 7×10^4 and 1.4×10^4 particles. The maximum index of the spectra was 1.25×0.20, found for the shower with an average number of particles of 2.9×10^5. The other indices were also close to unity but there was a trend to an increase in the index with the number of particles in a shower. C.F.Barnaby

2131 ON FLUCTUATION IN NUMBER OF μ-MESONS IN EXTENSIVE AIR SHOWERS.
V.Kalachyov, S.I.Nikolsky, A.A.Pomansky and E.I.Tukish.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 27 of 1960) Vol. II, p. 155-7.

The results are described of experiments to detect fluctuations the ratio of the numbers of μ-mesons and of electrons in showers etween 10^5 and 2×10^6 particles. The measurements were made at altitude of 3860 m at Pamir in the autumn of 1957. The apparatus nsisted of three groups of counters, each containing 24 self-quench- g counters and having an area of 330 cm^2. C.F.Barnaby

2132 DISTRIBUTION OF POINTS OF INITIATION OF E.A.S. K.Greisen, J.Delvaille and F.Kendziorski.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. II, p. 174-5.

An experiment is described designed to test the models of ex- eme fluctuations in the origin of extensive air showers. It is con- uded that the majority of all the recorded showers originated at gh altitude, which suggests that the mean free path for shower itiation is small compared with the absorption length of the second- y particles in the showers. The showers analysed were rather rge: the logarithmic mean value of the number of particles was early 3×10^7. C.F.Barnaby

2133 THE DISTRIBUTION IN DECLINATION AND THE CURVATURE OF THE SHOWER FRONT.
.F.Bradley and N.F.Porter.
osmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 427 of 1960) Vol. II, p. 176-8.

A brief report is given of an experiment using a directional herenkov counter in conjunction with an extensive air shower rray to investigate the arrival directions of air showers containing least 3×10^6 particles at sea-level. It was observed that showers hose cones fall North showed a northerly directional excess and at showers whose cones fall South showed a southerly directional xcess. C.F.Barnaby

2134 AN EXPERIMENT TO CHECK AN APPARENT NORTH–SOUTH ASYMMETRY IN ARRIVAL DIRECTION OF OSMIC RAY AIR SHOWER 10^5 PARTICLES.
B.A.McCusker, J.Malos and P.C.Poole.
smic Ray Conference, Moscow, 1959, English Edition (see Abstr. 27 of 1960) Vol. II, p. 179-84.

In a preliminary analysis of shower directions obtained in the dney air shower experiment, by fast-timing measurement, the istence of an apparent asymmetry in arrival directions was noted, mely, that there was an excess of showers arriving from the uth over showers from the north. An experiment is described to vestigate this asymmetry. Preliminary results after five months eration indicate that the asymmetry is not a real effect but is e to the increase in the detection sensitivity of the liquid scintil- ions used in the fast timing array caused by the scattering of air- ower electrons from the roof of the building. C.F.Barnaby

2135 THE LATITUDE EFFECT ON EXTENSIVE AIR SHOWERS OF COSMIC RAYS. S.Ozaki.
smic Ray Conference, Moscow, 1959, English Edition (see Abstr. 27 of 1960), Vol. II, p. 185-7.

The variation of extensive air shower intensity with latitude at t-level was investigated using four groups of Geiger counters ced on the deck of a ship travelling between New York and oan (via the Panama Canal). From the results it is shown that intensities of extensive air showers of about 10^8 particles are ependent (to within a few per cent) of the latitude in the region m 7^0 to 50^0 N. C.F.Barnaby

2136 CALCULATION OF SOME CHARACTERISTICS OF AIR SHOWERS TAKING FLUCTUATIONS INTO ACCOUNT.
G.Dedenko and G.T.Zatsepin.
smic Ray Conference, Moscow, 1959, English Edition (see Abstr. 27 of 1960) Vol. II, p. 201-8.

The probability of producing showers having a given number of rticles at sea-level due to primary photons of various energies is culated by the Monte-Carlo method. C.F.Barnaby

2137 A MODEL FOR THE INTERPRETATION OF AIR SHOWER DATA. T.E.Cranshaw and A.M.Hillas.
smic Ray Conference, Moscow, 1959, English Edition, (see Abstr. 7 of 1960) Vol. II, p. 210-13.

2138 DEPENDENCE OF VARIOUS EXTENSIVE AIR SHOWER CHARACTERISTICS ON TOTAL PARTICLE NUMBER.
S.I.Nikolsky and A.A.Pomansky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 214-19.

The analysis is described of air shower measurements made at an altitude of 3860 m in the Pamirs using over 1000 hodoscope counters arrayed in such a way that the location of the shower axis could be determined accurately. From a knowledge of the total number of particles in each extensive air shower, it was possible to obtain the dependence of various air shower characteristics on the total number of particles. Irregularities were found in the result when the total number of shower particles exceeded about 10^5. It is suggested that these irregularities may be either due to a drastic increase in the energy fractionation of the secondary particles for nuclear interactions of nucleus with energies greater than 10^{14} eV, or to transference of a large fraction of energy to the electron–photon component of the shower. C.F.Barnaby

2139 ELECTRON–PHOTON SHOWERS WITH ENERGIES FROM 10^{11} TO 10^{13} eV IN NUCLEAR EMULSIONS.
A.A.Varfolomeev, R.I.Gerasimova, I.I.Gurevich, L.A.Makar'ina, A.S.Romantseva and S.A.Chueva.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 283-9.

A detailed study is described of 15 electron–photon showers with energies greater than 10^{11} eV at small depths. Six emulsion stacks with a total volume of about 10 l. were used in the experiments. The number of electron–positron pairs observed at small distances from the closest electron track is given. The longitudinal development of the electron–photon showers recorded is discussed. The results are compared with cascade calculations carried out by the Monto Carlo method. C.F.Barnaby

2140 AN AIR SHOWER TELESCOPE AND THE DETECTION OF 10^{12} eV PHOTON SOURCES. G.Cocuoni.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. II, p. 309-11.

The possibility is discussed of detecting high-energy photons produced by discrete astronomical objects. Sources of charged particles are not considered because the smearing produced by the magnetized plasmas filling interstellar space probably obliterates the orginal directions of motion. C.F.Barnaby

2141 OBSERVATION OF THE POINT SOURCE OF COSMIC RAYS.
Y.Sekido, S.Yoshida, Y.Kamiya, H.Ueno and T.Muryama.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p.137-9.

The continuation of the experiments conducted in 1957 [Nuovo Cimento Suppl. (Italy), Vol. 3, No. 2, 482 (1958)] is reported. Between 1954 and 1956, observations with two counter telescopes at Nagaya, Japan, indicated a point source of cosmic-rays at a zenith of 80^0 and an azimuth of E 85^0. Since 1957 the observations were continued to obtain the time variations of the cosmic rays from the paint source. Results are given showing this variation over the period 1954-9. The correction of the position of the point source for the geomagnetic deflection of the cosmic rays is discussed. It is pointed out that not only is it necessary to correct for the deflection of primary protons but that the deflection of the secondary mesons, produced by the $p \rightarrow \pi \rightarrow \mu$ process is not negligible. C.F.Barnaby

2142 PRIMARY ENERGY SPECTRUM AND AIR SHOWERS. B.Peters.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 157-66.

An attempt is made to show that strong evidence exists for a break in the primary cosmic-ray spectrum at a magnetic rigidity corresponding to that of protons of about 10^{15} eV. The implications of such a discontinuity are discussed. C.F Barnaby

2143 MOMENTUM SPECTRA OF COSMIC RADIATION. H.Alfvén.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p.193-5.

A model is described to show how, by suitable magnetic pumping, charged particles can be accelerated to higher and higher energies. The results of the theory, applied to the cosmic radiation, are compared with those of the Fermi theory. C.F.Barnaby

2144 ON THE COMPOSITION OF PRIMARY COSMIC RAYS.
A.A.Korchak and S.I.Syrovatsky.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 211-19.

An analysis of the problem of the origin of cosmic rays is presented which shows that apparently only heavy nuclei are accelerated in the source and the composition observed near the earth results from the process of heavy nuclei fragmentation in interstellar gas. C.F.Barnaby

2145 ON THE DIFFUSION OF COSMIC RAYS IN THE GALAXY.
L.Davis, Jr.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. III, p. 220-5.

In discussing the connection between the element abundances in cosmic rays at the top of the atmosphere and the abundances at the point of origin, it is necessary to allow for the fragmentation of the original nuclei in traversing the interstellar gas. For this, some model of the storage of cosmic rays in the galaxy is needed in order to determine the amount of matter that the cosmic-ray particles have traversed between their acceleration to relativistic velocities and their arrival at the top of the atmosphere. It is the purpose of this paper to consider the efficiency of several of the models that have been used so far and to provide convenient formulae that can be used in a variety of simple models. C.F.Barnaby

2146 INTENSITY VARIATIONS OF COSMIC RAYS.
L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 7-17.

The present state of the knowledge is reviewed, with particular reference to the many results obtained during 1957-59. Some of the topics dealt with are: variations of the various cosmic-ray components (particularly the neutron component); the origin of cosmic rays; the modulation effects of cosmic rays; long-period variations in intensity and the knee-shift of the latitude effect; the effects of magnetic storms on cosmic rays; and the 27 day and solar-diurnal variations. C.F.Barnaby

2147 OBSERVATIONS OF SOLAR COSMIC-RAYS.
P.Freier, E.P.Ney, J.R.Winckler and P.J.Kellogg.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 95-100.

At the University of Minnesota, events representing the arrival of cosmic-ray protons from the sun were studied. The strongest event, which is described in detail, occurred between 10 and 13 May, 1957. Measurements were made by a sequence of balloons carrying small stacks of emulsions. The angular distribution, charge and energy spectrum of the particles are given. C.F.Barnaby

2148 THE KNEE OF THE LATITUDE CURVE AT BALLOON ALTITUDES.
H.V.Neher and H.R.Anderson.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 104-7.

The cause of the knee in the latitude curve at high altitudes is discussed. It is suggested that the latitude at which the knee occurs should be defined as that latitude at which the intersection of the best straight lines that can be drawn through the latitude curve on each side of the knee occurs. Experimental results are given of balloon flights with integrating ionization chambers to determine the latitude curves. It was found that the knee of the curve is at the same southern magnetic latitude in the region of 180° longitude as it is in the northern latitudes in the vicinity of 100° W longitude. Other features noted were: (1) an abruptness of the change of slope near the knee; (2) the small increase in radiation as one proceeds beyond the knee, amounting to only about one per cent between 56° and 90°. C.F.Barnaby

2149 ON THE CHARACTER OF COSMIC-RAY INTENSITY VARIATIONS DURING MAGNETIC STORMS.
L.I.Dorman.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960) Vol. IV, p. 111-28.

An attempt is made at a systematic exposition of the problem of the evaluation of different possible variants of Forbush-type depression profiles of cosmic-ray intensity during magnetic storms. This problem is important for an understanding of the nature of the modulation mechanisms of cosmic radiation and for studying the properties of corpuscular streams and the nature of their interaction with the earth. A study is also made of the problem of the possible effect of inhomogeneity of the magnetic field in a stream and of other subsidiary modulations of intensity on the observed profiles of cosmic-ray variations during magnetic storms. C.F.Barnaby

2150 INTENSITY VARIATION OF THE TOTAL COMPONENT IN ROME, FROM 1954 TO 1957.
F.Bachelet, A.M.Conforto and N.Iucci.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 7427 of 1960), Vol. IV, p. 153-4.

The results are given of the measurement of the total ionizing component of the intensity at sea-level by unshielded G.M. counter telescopes from April 1954 to June 1957, i.e. during the increasing phase of the solar activity. C.F.Barnaby

2151 24 HOUR INTENSITY VARIATIONS OF COSMIC RAYS OF ENERGY 2×10^{14} AND 2×10^{15} eV.
D.D.Krasilnikov.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 4727 of 1960) Vol. IV, p. 271-2.

Records of extensive air showers recorded during 1958 are used to examine solar-diurnal and sidereal diurnal variations in the frequency of air showers. It is pointed out that, because of the 24 hr temperature fluctuations of the atmosphere over the point of observation, one would expect to find oscillations of a 24 hr period in the air shower frequency in mean solar time. It is shown that the observed fluctuations are in good agreement with the expected values and also that the appearance of waves of a semi-diurnal period may be associated with corresponding pressure fluctuations of the atmosphere. C.F.Barnaby

2152 THE SOLAR VARIATION IN RATE OF EXTENSIVE AIR SHOWERS.
C.B.A.McCusker, D.E.Page and R.J.Reid.
Cosmic Ray Conference, Moscow, 1959, English Edition (see Abstr. 4727 of 1960) Vol. IV, p. 281-4.

There is now considerable experimental evidence of a variation in the rate of extensive air showers detected by certain types of apparatus. This variation is with solar time and seems to have components of 12 and 24 hr period. The experimental evidence is reviewed and an explanation of the effect is suggested: that the average height of the first interaction also varies regularly and that this variation is due to the oscillations of the atmosphere. C.F.Barnaby

NUCLEUS

2153 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE, KINGSTON, CANADA, AUGUST 29 - SEPTEMBER 3, 1960.
Edited by D.A.Bromley and E.W.Vogt.
Toronto: University of Toronto Press; Amsterdam: North Holland Publishing Co. (1960) 990 pp.

The conference was held at Queen's University, Kingston, Ontario, Canada under the sponsorship of the International Union of Pure and Applied Physics, and four Canadian scientific organizations The volume contains the text of 39 lectures and review papers delivered at the conference, with verbatim discussion, and the text of 126 of the research contributions submitted. Titles and brief abstracts of the remaining 248 research contributions received are also included. The contents are divided into ten chapters, with the following titles: Open problems in nuclear structure; Physical foundations of nuclear models; Gross properties of nuclear matter; Nuclear reaction mechanisms; Properties of individual levels, I and II; Statistics of nuclear levels and giant dipole resonances; Open session - Collective model, and Nuclear reactions (continued); Fission; Concluding session. The titles (with notes and abstracts in some cases) of the review articles, and abstracts of the published research contributions, will be found elsewhere in this or succeeding issues of "Physics Abstracts".

2154 NEUTRON–PROTON PAIRING INTERACTION.
A.N.Saxena.
Phys. Rev. (USA), Vol. 121, No. 2, 595-9 (Jan. 15, 1961).

The neutron–proton pairing interaction λ between the last odd neutron and the last odd proton in the outermost neutron and proton

lls of an odd—odd nucleus is estimated from nuclear masses in regions just beyond Z = 20, N = 20, and just beyond Z = 40, 50. Behaviour of λ in these two regions and in the heavy element ion Z > 82, N > 126, as estimated by Ghoshal and Saxena (Abstr. 5 of 1956), is discussed. It is found that the behaviour of λ may be erstood in terms of a simple jj-coupling shell model. According his model, λ arises from the spin-independent part of the two- y force and is proportional to $(2j_1 + 1 - 2z)(2j_2 + 1 - 2n)$, where the odd number of protons in the outermost proton shell j_1, and the odd number of neutrons in the outermost neutron shell j_2 he odd-odd nucleus.

THREE-BODY NUCLEAR PROBLEM WITH REPULSIVE RE FORCES. See Abstr. 2104

2155 CAN THE NUCLEAR MANY-BODY PROBLEM BE SOLVED BY USING PERTURBATION THEORY?
.Levinger.
lear Phys. (Internat.), Vol. 19, No. 4, 370-6 (Nov. (1), 1960).
A static two-body potential of Serber exchange character with epulsive core fails to produce saturation in first-order perturba- n theory, if the core is treated as a pseudo-potential (designating order of the term in a joint expansion in powers of the strength he attractive potential and in the range of the repulsive core). ond-order terms are estimated from the condition that satura- n should be achieved at the observed density without invoking ny-body forces. It is concluded that any static potential that duces saturation at about the empirical density must have sub- ntial second-order terms, of magnitude 10 MeV/particle or more. e author discusses the use of a velocity-dependent two-body ential to replace the infinite repulsive core, and finds that second- ler terms may be much smaller if one uses a velocity-dependent ential.

2156 ON THE DERIVATION OF THE OPTICAL POTENTIAL IN INFINITE NUCLEAR MATTER. B.Jancovici.
gr. theor. Phys. (Japan), Vol. 23, No. 1, 76-80 (Jan., 1960).
The optical potential is derived for a nucleon in infinite nuclear ter, all nucleons and interactions being symmetrically treated. exchange effects are exhibited; a previously neglected exchange ph, which has an important effect for the real part at low energy, iscussed and numerically computed.

2157 ROTATING SELF-CONSISTENT FIELDS AND ROTATIONAL STATES OF NUCLEI.
.Thouless and J.G.Valatin.
s. Rev. Letters (USA), Vol. 5, No. 11, 509-10 (Dec. 1, 1960).
It is shown that there are rotating solutions of the time- endent Hartree—Fock equations, which can represent the rotation nonspherical nucleus. This leads to a modification of the crank- model formula for the moment of inertia. The method is gene- zed to take account of pairing effects. D.J.Thouless

2158 EFFECT OF NUCLEAR ROTATION ON THE PAIRING CORRELATION. B.R.Mottelson and J.G.Valatin.
s. Rev. Letters (USA), Vol. 5, No. 11, 511-12 (Dec. 1, 1960).
The rotation of a nucleus tends to break up pairs, and so de- se the energy gap. Eventually the pairing is destroyed, and the nent of inertia should be close to its rigid body value for high tations. The magnitude of this effect is calculated, and it is d that the rotational spectrum should break off a little beyond highest levels that have been observed so far. D.J.Thouless

2159 NUCLEAR SPINS OF NEODYMIUM-147 AND PROMETHIUM-147.
abezas, I.Lindgren, E.Lipworth, R.Marrus and M.Rubinstein.
lear Phys. (Internat.), Vol. 20, No. 3, 509-12 (Nov. (2), 1960).
The nuclear spins of 11 day Nd^{147} and 2.6 year Pm^{147} were sured to be $I = \frac{5}{2}$ and $I = \frac{7}{2}$ respectively by the atomic beam netic resonance method. The result for Nd^{147} confirms an ier measurement made by paramagnetic resonance. The result Pm^{147} is suprising in view of the fact that no beta-transition observed between the ground states of these two isotopes.

2160 THE GYROMAGNETIC RATIO OF THE 80 keV ROTATIONAL STATE OF ERBIUM 166.
denstedt, H.J.Körner, C.Günther and J.Radeloff.
ear Phys. (Internat.), Vol. 22, No. 1, 145-56 (Jan., 1961).
The angular correlation of the 1380 keV—80 keV gamma-gamma ade in the decay of 27 hr Ho^{166} was measured in an external magnetic field of 13 550 G. The observed rotation yields for the nuclear g-factor of the 80 keV 2+ rotational state the value $g_R = +0.260 \pm 0.034$. A paramagnetic correction factor $\beta = 8.36$ (where $B_{eff} = \beta B_{ext}$) was applied in the calculation of this value There is a strong attenuation of the 1380 keV—80 keV angular correlation by internal fields. The attenuation factors for a liquid source of $HoCl_3$ in aqueous solution were determined as $G_2 = 0.80 \pm 0.08$, $G_4 = 0.56 \pm 0.04$. A measurement of the 1380 keV—80 keV angular correlation for different delays showed agreement with a time dependent attenuation

$$A_k(t) = A_k(0)e^{-\lambda_k t},$$

where the λ_k are $\lambda_2 = 0.09 \times 10^9$ sec^{-1}, $\lambda_4 = 0.30 \times 10^9$ sec^{-1}. The ratio of λ_4/λ_2 suggests that the attenuation is caused mainly by magnetic interaction between the 4f electron shell and the magnetic moment of the nucleus. The spin relaxation time for the 4f electron shell was calculated as $\tau_J = (3.4 \pm 0.9) \times 10^{-13}$ sec.

2161 APPROXIMATE VALUES OF SOME ELECTRIC QUADRUPOLE MOMENTS OF NUCLEI OF MASS A > 218. R.Foucher.
J. Phys. Radium (France), Vol. 20, No. 10, 836-7 (Oct., 1959). In French.
The electric quadrupole moments and the lifetimes of the first excited states of the even—even deformed nuclei in the region $218 \leq A \leq 236$ are estimated, using some measured values of $\alpha-\gamma$ angular correlations and of lifetimes, and some assumptions of smooth variation between neighbouring nuclei. J.Goldstone

2162 NUCLEAR MOMENT OF Ce^{137m} BY NUCLEAR ALIGNMENT.
J.N.Haag, C.E.Johnson, D.A.Shirley and D.H.Templeton.
Phys. Rev. (USA), Vol. 121, No. 2, 591-4 (Jan. 15, 1961).
Nuclei of Ce^{137} and Ce^{137m} were aligned at low temperatures in a single crystal of neodymium ethylsulphate nonahydrate by means of the magnetic h.f.s. coupling with the electrons of the Ce^{3+} ions. The anisotropy of their gamma radiation was observed. The magnetic moment of Ce^{137m} is $|\mu n| = 0.96 \pm 0.09$ n.m. The spin of Ce^{137m} is established as $\frac{11}{2}$.

2163 MEASUREMENT OF THE ROTATIONAL g-FACTOR (g_R) FOR SEVERAL NUCLEI. G.Manning and J.Rogers.
Nuclear Phys. (Internat.), Vol. 19, No. 6, 675-87 (Dec. (2), 1960).
The g-factors of several excited states of nuclei were measured by observing the rotation of the angular correlation for a source in a magnetic field. The results are: 122 keV state of Sm^{152} ($\tau = 2.0 \times 10^{-9}$ sec) $g = 0.28 \pm 0.07$; 123 keV state of Gd^{154} ($\tau = 1.7 \times 10^{-9}$ sec) $g = 0.4 \pm 0.5$; 81 keV state of Er^{166} ($\tau = 2.4 \times 10^{-9}$ sec) $g = 0.31 \pm 0.06$; 87 keV state of Dy^{160} ($\tau = 2.5 \times 10^{-9}$ sec) $g = (0.28 \pm 0.08)$; 118 keV state of Tm^{169} [$\tau = (9.0 \pm 1.5) \times 10^{-11}$ sec] $g = 0.20 \pm 0.06$. The assumptions used in deducing the g-factors from the observed rotations are discussed. A discussion of available evidence suggests that the rotational g-factor g_R is less than Z/A. The g-factor of the 118 keV state of Tm^{169} is discussed on the basis of the Nilsson model.

2164 THE NUCLEAR ZEEMAN EFFECT IN Sn^{119}.
N.N.Delyagin, V.S.Shpinel', V.A.Bryukhanov and B.Zvenglinskii.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 3(9), 894-6 (Sept., 1960). In Russian.
The dependence of the resonance absorption of γ-quanta, with an energy of 23.8 keV, on the velocity of the source was determined, alternately, with the absorber placed in a constant magnetic field of 1215 Oe, and also in the absence of any external magnetic field. Values of $(1.2 \pm 0.2) \times 10^{-7}$ eV for the distance between the components of the hyperfine structure in crystalline tin, and $-(1.1 \pm 0.3)$ nuclear magnetons for the magnetic moment of the ground state were obtained in good agreement with previous results. The magnetic moment of the excited state was found to be $+(1.9 \pm 0.4)$ nuclear magnetons, which is higher than the value predicted by the single particle model. [English translation in: Soviet Physics—JETP (USA)]. E.A.Sanderson

INTERNAL-FIELD MEASUREMENTS IN FERROMAGNETS, USING THE MÖSSBAUER EFFECT. See Abstr. 1210

2165 THE THEORY OF HYPERNUCLEI.
D.D.Ivanenko, V.A.Lyul'ka and V.A.Filimonov.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 4, 663-85 (Aug., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 4, 564-79 (July-Aug., 1959).
A review of experimental and theoretical work. S.J.Goldsack

2166 ON THE POSSIBILITY OF DETERMINING THE SPIN OF $_{\Lambda}H^{4}$ FROM THE ANGULAR DISTRIBUTION FOR MESONIC DECAY. D.Chlebowska and J.Szymański.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 10, 643-9 (1959).
The authors consider the decay $_{\Lambda}H^{4} \rightarrow t + p + \pi$. It is shown that, because of interactions in the final state, small differences exist in the calculated angular distribution and energy spectrum at the decay, depending on the spin of the $_{\Lambda}H^{4}$, and on the P/S ratio for the decay. With sufficient statistics it should be possible to determine either one, if the other is known. S.J.Goldsack

Energy Levels

2167 NUCLEAR SPECTROSCOPY WITH NON-LOCAL POTENTIALS. A.N.Mitra and S.P.Pandya.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 455-63 (Nov. (2), 1960).
A non-local separable potential derived earlier was used to calculated the T = 0 energy levels of the shell-model configuration $(d_{3/2})^2$. The results are satisfactory, and the advantages of such a realistic and well-behaved potential over the other potentials, local but invoking singularities, hard cores etc., for calculating nuclear energy levels are pointed out.

2168 NUCLEAR RESONANCE SCATTERING OF BREMSSTRAHLUNG. E.C.Booth.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 426-35 (Nov. (1), 1960).
Nuclear resonance scattering of bremsstrahlung was observed in six cases of light-to-medium weight nuclei.. The results agree with previous measurements for the known cases. Mean lifetimes not previously reported are:

Nucleus	τ/g (10^{-13} sec)
F^{19} (1.34 MeV)	0.5 ± 0.3
P^{31} (1.26 MeV)	3.4 ± 1.5
Cu^{65}(0.77 MeV)	3.3 ± 1.5

where $g = (1 + 2I)/(1 + 2I_0)$.

2169 ROTATION–VIBRATION INTERACTION IN NON-AXIAL EVEN NUCLEI. A.S.Davydov and A.A.Chaban.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 499-508 (Nov. (2), 1960).
Collective excitations of even nuclei are investigated without dividing the excitations into rotational and vibrational. The conditions which enable one to distinguish between rotational and vibrational excitations are investigated. Correction terms are determined which take into account the interaction between both types of excited states. Level energies are determined for non-spherical nuclei for which division of the excitations into rotational and vibrational ones is meaningless.

2170 THE INTERACTION ENERGY OF THE LAST NEUTRON AND LAST PROTON IN ODD–ODD NUCLEI.
C.Ythier and R.Van Lieshout.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2332-4 (Nov. 21, 1960). In French.
The variation, as a function of the number of neutrons, of the interaction energy of the last proton and neutron in odd–odd nuclei, is found to have a fine structure, which the authors suggest is probably related to the constituents of the even–even core. This fine structure is compared with the analogous structure observed in the variation, as a function of the number of neutrons, of the excitation energy of the first 2^+ level in even–even nuclei. A.M.Green

2171 ENERGY LEVELS IN CHROMIUM ISOTOPES.
F.A.El Bedewi and S.Tadros.
Nuclear Phys. (Internat.), Vol. 19, No. 6, 604-13 (Dec. (2), 1960).
A magnetic spectrograph with photographic detection is used to study the proton groups emitted from the deuteron interaction with a thin chromium target. Applying deuterons of energy 8.67 MeV, nine well-defined proton groups attributed to the isotope 52 of chromium yield Q-values of 5.73, 5.16, 4.72, 3.41, 3.04, 2.11, 1.60, 1.50 and 1.09 MeV with errors of ± 0.02 MeV. Four weak groups of protons having Q-values of 6.68, 6.26, 4.89 and 4.46 MeV with errors of ± 0.03 MeV may belong to the $Cr^{53}(d, p)Cr^{54}$ reaction. In view of the present energy levels in Cr^{53} and Cr^{54}, interpretation of some gamma ray groups obtained in previous work on neutron capture of chromium is given. The angular distributions for the proton groups corresponding to the transition to the ground state and five low lying levels in Cr^{53} are compared with theoretical curves based on deuteron stripping mechanism. Odd parity is identified for all the examined energy levels and information about their possible spins, relative capture probabilities and relative reduced widths is obtain

2172 NUCLEAR STRUCTURE OF Ne AND Mg.
C.G.Bedreag.
Bul. Inst. Politeh. Iasi (Roumania), Vol. 5(IX), No. 1-2, 143-50 (1959). In French.
The energy levels of Ne^{21}, Ne^{20} and Mg^{24} are briefly discussed in terms of the collective model and an alpha-particle model.
L.L.Gree

2173 CAPTURE-GAMMA DETERMINATION OF V^{52} LEVELS.
J.E.Schwäger.
Phys. Rev. (USA), Vol. 121, No. 2, 562-8 (Jan. 15, 1961).
Thermal-neutron capture-gamma radiations for the $V^{51}(n,\gamma)V^{52}$ reaction were observed with a fast-coincidence scintillation spectrometer developed for the Livermore 1 MW pool-type reactor. The added-neutron binding energy in V^{52} was measured as 7.30 ± 0.05 MeV and a decay scheme was established which verifies a previously proposed $V^{51}(d,p)V^{52*}$ level scheme. Several low-energy crossover, without stopover, transitions were observed: two from the 0.78 MeV level to the ground and 0.13 levels (the latter being the more intense) but not to the 0.42 level, and one from the 0.83 MeV level to the ground state only. The 0.42 MeV level makes both crossover and stopover transitions to the ground and 0.13 MeV levels (the former being the stronger). Some evidence exists to suggest that the low-lying V^{52*} states arise from excitations of the $(1f_{7/2})^3$ proton configuration alone.

2174 CAPTURE-GAMMA DETERMINATION OF V^{51} LEVELS.
J.E.Schwäger.
Phys. Rev. (USA), Vol. 121, No. 2, 569-80 (Jan. 15, 1961).
See preceding abstract. The added-neutron binding energy in V^{51} was measured as 11.1 ± 0.1 MeV. Cascade radiations for V^{51*} were observed and a decay scheme is established which verifies a previously proposed (p,p') level scheme. Spin assignments for most of the $V^{51}(p,p')$ reported levels below 4.0 MeV are proposed and the level order for the $(1f_{7/2})^3$ proton configuration levels is established as $\frac{7}{2}^-$ (ground state), $\frac{5}{2}^-$, $\frac{3}{2}^-$, $\frac{11}{2}^-$, $\frac{9}{2}^-$, and $\frac{15}{2}^-$ spin with excitation energies of 0.32, 0.93, 1.61, 1.81, and 2.70 MeV, respectively. Of the various nuclear force assumptions that can be made the short-range force approximation (δ-type interaction) and weak surface-coupling effects for V^{51*} configuration states appear to give the best match between theory and experiment. A previous calculation using experimentally measured splittings of the j^3 configuration together with tabulated coefficients of fractional parentage gives excellent agreement with experiment. Evidence is also found for $(1f_{7/2}^2)_0 2p_{3/2}$- and $(1f_{7/2}^2)_0 1f_{5/2}$-proton single-particle levels at 2.41 and 2.55 MeV, respectively, as well as for additional low-spin states between 2.70 and 3.38 MeV which possibly represent even states resulting from excitation of a lower shell proton to give a $(1f_{7/2}^4)_0$ configuration plus a proton hole in the vacated shell. Experimental results suggest that the V^{51*} 20-28 core is a more rigid structure than the Ca^{43*} 20-20 core.

NUCLEAR DECAY RADIOACTIVITY

2175 ALPHA-PULSE ANALYSIS BY SCINTILLATION DETECTORS.
G.Bertolini, A.M.Del Turco and G.Restelli.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 3, 350-4 (June, 1960).
The light output of CsI(Tl), NaI(Tl) and plastic crystals to alpha-particles of 4.68, 5.3, 5.8, 6.05 and 8.78 MeV was investiga

...ve conversions for the 5.3 MeV line of Bi^{213} were respectively ... to be 0.1, 3 and 5 %. The relative efficiency to alpha and beta ... and the mean energy as a function of the energy is given. ... branching ratio, $\alpha/\beta = 0.4$ of $Th-C$ was determined to be 0.36 ± 0.02 ...

2130 APPLICATION OF SOLVENT EXTRACTION TECHNIQUES TO LOW LEVEL BETA ACTIVITY
...SUREMENTS BY CHERENKOV RADIATION
...ham and L. E. Glendenin
...ear Science and Technology (Academic Press, Inc., New York, N. Y.), Vol. 1, No. 2, pp. 75–83 (1960).

...new apparatus employing coincidence techniques for measuring ... background of 2.5 ± 1 counts per minute. The efficiency ... 80 to more than 2 counts per minute was determined for the ... of low level beta activity of the order of 40 mμc. The ... and their use in radiochemical separations. This ... of a single scintillator to be used for two or more ... only two have been described. The apparatus was ... for the study of the kinetics of solvent extraction ...

2131 TOTAL DETECTION EFFICIENCY FOR RADIOACTIVE ELEMENTS. S. A. Reynolds
...ence, 1960, Vol. 131, No. 3412, pp. 1503–1504, (May 20, 1960).

...ency is derived and used in a formula involving the ... of the count rates of two counters, one of which is ... to 1 or 2 π, in 4π.

P. C. Bruns

2132 A RADIOCARBON DATING SYSTEM USING SCINTILLATION TECHNIQUES. C. F. G. Delaney and J. E. McKinlay
...ear Sci. Datum Ser. A (Ireland), Vol. 1, No. 1, 1–21 (Dec. 2, ...

...le to be dated is converted to methyl alcohol and ... with a liquid scintillator. The scintillation cell of sheet ... used by two photomultipliers operating in coincidence. The ... counting rate is reduced by pulse screening and by ... selection. The net contemporary carbon counting rate ... assume a background counting rate of 10.5 ± ... counting period the system will give results of ... to 30,000 years. A description of the counting ... and some results are presented.

2133 THE ATTACHMENT OF RADIOACTIVE ATOMS ON AEROSOLS SUSPENDED CHEMICAL AGENTS IN THE ... (RADIR). L. Lassen and H. Weinke...
...Germany), Vol. 18, No. 2, 138–45 (1961). In German.

...attachment of the decay products of uranium emanation to ... particles was studied. The dependence of the attached activity ... particle size was determined for spherical particles with ... ranging from 0.7 to 5 μ. The particles used were solid spheres ... wax. It is found that the attached activity is proportional ... radius of the particles which is in good agreement with theory ... size range. See Abstr. 1121 of 1961.

...TMOSPHERIC TRANSPORT OF ARTIFICIAL RADIO... ...ITY. See Abstr. 1125.

2134 LIMITS OF STABILITY AND PROTON AND TWO-PROTON RADIOACTIVITY OF EIGHTEEN-ELECTRON ... PAIR OF LIGHT NUCLEI. V. I. Goldanskii.
...Exper. Teor. Fiz. (USSR), Vol. 38, No. 2(8), 497–501 (Aug., 1960) ...

...ation of isotopic invariance principles to light nuclei ... very simple relation between the neutron and proton binding ... in mirror nuclei. On basis of this relation, the ... of stability of neutron-deficient isotopes of light nuclei with ... to proton emission can be established and the existence and ... of approximately 80 such isotopes can be predicted. ... are discussed for which proton radioactivity or the very ... phenomenon of two-proton radioactivity can be observed. ... properties of this interesting phenomenon are analyzed ... in detail. Soviet Physics—JETP (USA), Vol. 12, No. 2, Feb. 1961, ...

...THE NEW ISOTOPIC STATES OF SPHERICAL NUCLEI OF ... WITH ODD MASS NUMBERS.
...Nucl. Phys. (USSR), Vol. 111, No. 4, 781–91, Aug. 1, 1960. ...

The M2 and E3 transitions, resulting from the presence of the $5_{1/2}$ level in the level schemes of the nuclei Eu^{151}, Eu^{153} and Eu^{155}, were investigated using the method of coincidences. For the coincidences of the K-conversion lines with energies 121 keV and 197 keV, corresponding to the above nuclei, were measured and from the relative intensity ratios the period of half decay for the excited level was determined. The dependence of the coincidence probability on the number of scattering centers between source and detector was measured. This dependence is not apt to yield a negative parity for the ground state of Eu^{151} as given by Mihelich (Abstr. 3524 of 1957) and Goldhaber (Abstr. 3526 of 1956). [English translation in: Soviet Physics—Doklady (USA).]

E. A. Sanderson

2142 THE SPECTRUM OF Be^8 PRODUCED IN THE β-DECAY OF Li^8
...Burnel, R. Bouchez, C. Gérardin and D. Maurice-Valentin.
...C.R. Acad. Sci. (Paris), Vol. 251, No. 17, 1771–3 (Oct. 24, 1960), ... in French.

The Li^8 was formed by the bombardment of a 0.2 mg cm^{-2} target of natural lithium with 5 MeV deuterons. Resulting Li^8 nuclei were collected on a rotating axle, and after said a revolution ... sec ... were removed to the detector unit. Surface-barrier and a ... magnet were used as detectors of the particles from Be^8. They give similar results with an abundance of beta ... between 3 and 10 MeV.

A. Abrahamson

2143 HALF-LIFE OF O^{14}
...D. L. Hendrie and J. R. Gerhart
...Phys. Rev. (USA), Vol. 121, No. 3, 841–4, Feb. 1, 1961.

The said half-life was remeasured and found to be 71.31 ± 0.16 sec. The corresponding partial half-life for the $V^- - V^+$ beta transition is found to be 71.24 ± 0.18 sec. These results are about 1.8% less than reported earlier. The new half-life is compared with the O^{15} and proton energy as determined by Barker et al. (Abstr. 681 of 1960) ... to be correct by Freeman, ... Kavanagh (to be published). From ... the mean life of the β-emitter is calculated. The ... is given that the observed value of 0.1 ± 0.4 ... the ... ...ements of Konopinski and Uhlenbeck are used, and by ... a ... the relative ... of Gamow et al. are used.

2144 A TENTATIVE EXPLANATION OF SMALL DEVIATIONS OBSERVED IN BETA SPECTRA. Z. Kaniowski
...Bull. Acad. Polon. Sci., Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 3, 109–14 (1959).

Discusses the implications of the deviations from theoretically ... Fermi—Kurie plots observed in electron spectra of P^{32}, Y^{90}, In^{115} and Nd^{147}. The small deviations may be explained by the ... suppression of usually dominant matrix elements. New terms ... to the ... correlation ... could be introduced, ... the experimental accuracy are so complex as to preclude any ... conclusions.

R. E. Thomas

2145 HIGHER-ORDER EFFECTS IN AN ALLOWED POSITON DECAY IN Cl^{34}
...S. L. Ruby, J. J. Kraushaar and J. R. Rose.
...Bull. Amer. Phys. Soc., Ser. II, Vol. 5, No. 2, 217 (Jan., 1960).

The allowed positon decay of Cl^{34} to the second excited state of S^{34} has the unusually large log f value of 8.7. The directional ... of this positon group with the two coincident gamma-rays of energy 2.11 and 1.19 MeV which depopulate this level, was measured as a function of beta energy from 1.7 to 3.2 MeV to yield new information about the decay to this level. A magnetic spectrometer was used as the beta analyzer. An anisotropic correlation was measured, $A_{exp} = 2.5$–3.5% near 1.2 MeV. This is only the ... case where such a correlation has been measured in an allowed beta decay and it is much larger than the other two. An explanation ... be found in higher order terms predicted by the Gell-Mann theory of ... in terms of cross terms between allowed and second forbidden matrix elements. ... between the ... and experiment can be considered favorable.

2146 INVESTIGATION ON THE DECAY SCHEME OF THC Eu^{152}. M. Grenier, D. Prosperi, and S. Scuri.
...Nuovo Cim. Internat. Vol. 16, No. 4, 561–8, Nov. 1, 1960.

The gamma-rays emitted in the β-decay of Eu^{152} were investigated by means of α—α, α—γ, and γ—γ coincidences. New gamma-rays of 1.12 and 1.19 MeV were found. The existence of 1.41 and 1.46 MeV transitions, recently reported, was confirmed.

while no evidence of 1.3, 1.8, and 2.2 MeV transitions, reported by some authors, was found. An improved decay scheme of Bi^{212} is given. Semi-empirical calculations show the spin and parity of the first excited level (0.73 MeV) to be 2^+, as expected.

2187 A SEARCH FOR DOUBLE DIPOLE DE-EXCITATION IN C^{12}. G.J.McCallum, D.A.Bromley and J.A.Kuehner.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 382-94 (Nov. (2), 1960).

An experimental search for the simultaneous quanta which would result from double E1 electromagnetic de-excitation of the 4.43 MeV, 2^+ state in C^{12}, in competition with the normal E2 de-excitation, yielded negative results. The 4.43 MeV state was populated via the resonant $N^{15}(p,\alpha)C^{12}$ reaction; competing proton capture reactions preclude the establishment of an experimental limit on the branching ratio $\Gamma 2E1/\Gamma E2$ of less than 1.7×10^{-4}. It is suggested that this limitation applies generally to reaction studies of this branching ratio. Recent theoretical studies of this process suggest that $\Gamma 2E1$ vanishes in first order, consistent with the experimental observations.

2188 CIRCULARLY POLARIZED ANGULAR CORRELATIONS IN THE CASE OF EUROPIUM 152.
J.Berthier, P.Debrunner, M.Lambert and R.Lombard.
C.R. Acad. Sci. (France), Vol. 251, No. 9, 1065-7 (Aug. 29, 1960).
In French.

The anisotropy of the degree of circular polarization of γ-rays following β decay as a function of the angle between β and γ rays was measured for a $3^- \rightarrow 3^- \rightarrow 2^+$ allowed transition in Eu^{152} and is compared with that of an analogous transition in Sb^{124}.
A.E.I. Research Laboratory

2189 A $4^+ - 0^+$ CROSS-OVER TRANSITION.
H.Morinaga and K.Takahashi.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1460-1 (Oct., 1959).

An E4 crossover transition was detected in the decay of the 4^+ 2.505 MeV level of Ni^{60}, for which the more probable mode of decay is via the 2^+ first excited state at 1.333 MeV. A heavy water sample was irradiated by a 10 000 curie Co^{60} source and photoneutrons produced by 2.505 MeV γ-rays detected by a 2.32 hour activity induced in dysprosium. The possibility of photoneutrons being produced by other high energy γ-rays from contaminants was considered. A branching ratio of the crossover transition to the cascade transition of 4×10^{-7} was obtained. The Weisskopf single particle model predicts a ratio of 1.3×10^{-7}. R.E.Meads

2190 ON THE DECAY OF 5.8 d Sb^{120}, 5.1 h Sb^{118} AND 1 h Sb^{116}.
B.S.Jensen, O.B.Nielsen and O.Skilbreid.
Nuclear Phys. (Internat.), Vol. 19, No. 6, 654-64 (Dec. (2), 1960).

Activities of Sb^{116}, Sb^{118} and Sb^{120} were produced in the Sn(d, n)Sb or In(α, n)Sb reactions. Sources for β- and γ-ray spectroscopy were prepared in an isotope separator. The radiations were studied in two six-gap β-ray spectrometers and by scintillation spectrometers in conjunction with a 100-channel kicksorter. The decay scheme of McGinnis for Sb^{120} is confirmed, and schemes for 1h-Sb^{116} and 5.1h-Sb^{118} are proposed. The level schemes of the single closed-shell nuclei Sn^{116}, Sn^{118} and Sn^{120} are compared with the calculation of Kisslinger and Sorensen.

2191 DECAY OF Ho^{156}.
E.P.Grigor'ev and B.S.Dzhelepov.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 3, 564-7 (Nov. 21, 1960).
In Russian.

A study was made of the conversion spectrum of Ho^{156}. The half-life of the 366.7 keV transition was found to be 57 ± 3 min. By comparison of the measured ratios K/L and L_{I+II}/L_{III} with theoretical predictions, it was possible to ascribe E2 multipolarity for the transitions 138.0, 266.4 and 366.7 keV. It was concluded that the decay of Ho^{156} leads, to a large extent, to highly excited levels of Dy^{156} with spin 4, 5, or 6, one of which could be the new 1089.6 keV level derived from the results of this study. [English translation in: Soviet Physics—Doklady (USA)].

2192 ORBITAL ELECTRON CAPTURE BY THE NUCLEUS.
R.Bouchez and P.Depommier.
Rep. Progr. Phys. (GB), Vol. 23, 395-452 (1960).

The general properties of orbital electron capture are reviewed. Energetic considerations, radiations associated with capture (X-rays and Auger electrons) and their experimental investigation are discussed. Taking into account the new results on the β-interaction, formulae for transition probabilities for any order of forbiddenness are calculated by means of the spherical tensor method and using two component neutrino theory with (V,A) interaction. L/K ratios are computed from these formulae, using the bound electron wave functions given by Brysk and Rose. These theoretical results have been compared with the experimental data and the agreement is fairly good. K/β^+ ratios are also computed, using Dzelepov's tables for the β^+ spectrum and Brysk's and Rose's functions for the K-electron. For allowed and "unique" transitions the calculated values agree with experiment.

2193 ON THE MEASUREMENT OF ORBITAL ELECTRON CAPTURE WITH PARTICULAR REFERENCE TO ^{131}C
B.R.Joshi and G.M.Lewis.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 349-54 (Sept., 1960).

A scintillation-counter method, which eliminated the need for escape corrections, was developed for the measurement of L/K capture radio for intermediate and high-Z nuclei. With this method the L/K capture ratio was determined for Cs^{131} at 0.153 ± 0.008. The computed value for this simple allowed transition, of known energy, is 0.145, which lies only marginally lower.

2194 L TO K CAPTURE RATIO IN THE DECAY OF Ge^{68}.
M.K.Ramaswamy.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 377-9 (Nov. (1), 1960).

The L to K capture ratio in the decay of 270 day Ge^{68} was determined by comparing the number of K X-rays with the amount of annihilation radiation in the decay of 68 minute Ga^{68}. This leads to a L/K ratio of 0.12 ± 0.07 in good agreement with theory.

2195 INTERNAL CONVERSION ELECTRONS OF ^{167}Tm.
S.Chojnacki, R.Sosnowski, O.Wołczek, I.A.Yutlandov, H.Lancman and J.Zylicz.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vo
No. 8, 535-8 (1959).

The electron spectrum of Tm^{167} was examined using a magne spectrometer and conversion lines were found at 56.7 kV, 207.5 k and 477 kV. From previous measurements of the internal coeffi cient in the K-shell for 207.5 kV transition and the relative inter sities of the 207.5 and 534 kV gamma-lines, the conversion coef cient of the K-shell for the 534 kV transition is calculated to be $\alpha_K = (2.0 \pm 0.8) \times 10^{-3}$. This sets the spin of the 742 kV level as $\frac{1}{2}$ or $\frac{3}{2}$ and its parity even. R.H.Thom

2196 DECAY OF $_{68}Er^{161}$ (3.1 hr).
H.A.Grench and S.B.Burson.
Phys. Rev. (USA), Vol. 121, No. 3, 831-40 (Feb. 1, 1961).

Sources of Er^{161} (3.1 hr) were produced by the (n, 2n) and (γ, reactions. A study of the gamma-ray spectrum by means of scin lation coincidence spectrometry indicated 32 gamma-rays. All b three of these are fitted into a tentative decay scheme with levels at 0, 211, 585, 826, 945, 1165, 1253, 1315, 1395, 1450, (1604), 170 and 1830 keV. The data are consistent with a $\frac{7}{2}^-$ spin assignmen the Er ground state and $\frac{7}{2}^+$ and $\frac{1}{2}^+$ assignments to the ground sta and 211 keV state of Ho, respectively. The 826 keV level in Ho probably has $\frac{5}{2}^-$ character.

2197 THE DECAY OF Pb^{212}.
P.G.Roetling, W.P.Ganley and G.S.Klaiber.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 347-59 (Nov. (2), 1960).

The gamma-rays of Bi^{212} following the beta-decay of 10 hour Pb^{212} were studied using gamma response function analysis, coinc dence spectroscopy and directional correlation techniques. The coincidence results agree in general with the level scheme propo by Krisyouk et al. (Abstr. 5303 of 1958). However, a 177 keV gam ray was found, showing that transition to be M1 rather than E0. The weak 415 keV gamma radiation was observed for the first time, and intensities assigned to all gamma-radiations. Angular correlation experiments show the spins of the 415 keV and 300 ke levels to be 1 and 2 respectively, in disagreement with Krisyouk.

2198 DIRECTIONAL AND POLARIZATION CORRELATION STUDIES IN THE DECAY OF 5-HOUR Sb^{118}.
M.K.Ramaswamy, W.L.Skeel, D.L.Hutchins and P.S.Jastram.
Phys. Rev. (USA), Vol. 121, No. 2, 553-7 (Jan. 15, 1961).

Directional and polarization correlation measurements were made on the gamma rays accompanying the decay of 5 hr Sb^{118}. These measurements lead to the following spin and parity assignments for excited levels in Sn^{118}: 1.22 MeV (2^+), 2.25 MeV

and 2.51 MeV (5⁻). A search for positrons was made, and an r limit on positron emission was set at 0.2% of the 1.22 MeV ys, giving a lower limit of 2500 hr for the partial half-life of tron emission to any of the excited levels in Sn^{118}. The level me is discussed in terms of various nuclear models.

199 BALANCED ION CHAMBER MEASUREMENT OF HALF-LIVES OF SEVERAL RADIOISOTOPES.
Easterday and R.L.Smith.
ear Phys. (Internat.), Vol. 20, No. 2, 155-8 (Oct. (4), 1960).
Half-lives of six gamma emitters were measured using a nced ion chamber arrangement with one chamber driven by a um source. Data analysed by least squares yielded the following lts: Se^{75}, 120.4 ± 0.2 d; Zn^{65}, 245.7 ± 1.1 d; Ru^{106}, 265.8 ± 1.7 d; ^{m}, 255.0 ± 0.8 d; Cs^{134}, 2.05 ± 0.05 y; Ce^{144}, 277 ± 4 d.

2200 DECAY SCHEME OF Tb^{152}.
K.S.Toth, O.B.Nielsen and O.Skilbreid.
ear Phys. (Internat.), Vol. 19, No. 4, 389-99 (Nov. (1), 1960).
The decay scheme $Tb^{152} \rightarrow Gd^{152}$ was investigated with sources pared in an isotope separator. In addition to obtaining γ-ray conversion-electron spectra, $\gamma-\gamma$ and $e-\gamma$ coincidence measure-ts were carried out. A disintegration scheme was established includes all transitions in Gd^{152} reported in earlier Eu^{152} β-decay ies. In addition, four new transitions which establish two excited ls in Gd^{152} were observed. One of these is a 0^+ state at 1047 keV the other, at 929 keV, has probably spin 2^+. The 0^+ state decays two monopole transitions to lower 0^+ states, and the transition n the 929 keV level to the 344 keV first excited level seems to ain a considerable E0 admixture. The two new levels are tenta-ly interpreted as members of a three-phonon quintet.

NUCLEAR REACTIONS

(Including scattering by nuclei)

2201 EFFECT OF FINITE LIFE OF UPPER LEVEL ON PROBABILITY OF COULOMB EXCITATION.
reit and R.L.Gluckstern.
lear Phys. (Internat.), Vol. 20, No. 2, 188-201 (Oct.(4), 1960).
'he effect of the finite life of the upper level on the probability oulomb excitation is calculated in the semiclassical approxi-ion. The problem is first treated by considering the upper level e coupled to the continuum by means of a matrix element as in Weisskopf-Wigner treatment of emission and absorption in ation theory. Equations for the excitation probability at inter-iate times are worked out. The overall transition probability n the ground state to the continuum is transformed in terms of ntegral over energies for a transition to a level with infinite life . The result is then interpreted and generalized in terms of ct transitions to the continuum of stationary states without ng use of the division of the nuclear Hamiltonian into parts h provided the matrix element of the first treatment. The nd approximation provides a more accurate formula for the all transition probability and relates the Coulomb excitation ability directly to the Einstein absorption probabilities per unit ency range. A schematic illustration is given for the increase e number of transitions from the ground state.

2202 RECOIL TECHNIQUE IN CYCLOTRON BOMBARDMENTS USING POWDER TARGETS.
dersson, G.Rudstam and T.Stenström.
ear Instrum. and Methods (Internat.), Vol. 7, No. 1, 73-5 l, 1960).
A new bombardment technique based on the catching of recoils gets of mixed powders facilitates the carrier-free separation clotron-produced nuclides. The methods is applicable even to pes of the target element. In preliminary experiments useful s were about 10% of those obtainable from a pure target.

Due to Photons

2203 A STUDY OF THE RESONANT SCATTERING OF PHOTONS BY MAGNESIUM.
M.Langevin and A.Bussière De Nercy.
J. Phys. Radium (France), Vol. 20, No. 10, 831-2 (Oct., 1959). In French.
Reports measurements made of the resonant scattering of 12.5 MeV bremsstralung γ-rays in a magnesium sample of thickness 5.72 g/cm. The energy of the peak in the spectrum was 10.3 MeV. R.H.Thomas

2204 PHOTOPROTONS FROM Cs AND I.
R.B.Taylor.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 453-60 (Nov. (1), 1960).
A study was made of photoprotons emitted from Cs and I by irradiating a thin CsI:Tl crystal with a bremsstrahlung beam and detecting the protons in the same crystal. The photoproton spectra for different bremsstrahlung end-point energies all show a broad peak at 8 MeV after correcting for "escape" protons. The proton yield was also measured and a peak cross-section of (18 ± 2) mb found at 25 MeV, while the integrated cross-section to 32 MeV was measured as (136 ± 30) MeV.mb.

2205 ENERGY SPECTRUM OF THE PHOTONEUTRONS FROM GOLD. R.F.Askew and A.P.Batson.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 408-16 (Nov. (2), 1960).
The energy spectrum of the neutrons produced at 90° to a gold target bombarded with 55 MeV bremsstrahlung was measured. Nuclear emulsions were used to detect the photoneutrons. The spectrum shows two peaks. The large peak at 1.25 MeV can be interpreted as due to the statistical decay of the compound nucleus. The smaller peak at about 5.5 MeV is assumed to come from a "direct" transition, as described by the Wilkinson model (1956). In the appendix a new method is presented for the calculation of the corrections involved for those proton recoils which leave the emulsion.

2206 FINE STRUCTURE IN THE $N^{14}(\gamma, n)N^{13}$ ACTIVATION CURVE.
N Mutsuro, Y.Ohnuki, K.Sato, K.Kageyama and M.Kimura.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1457-8 (Oct., 1959).
The activation curve was measured in the energy region 10-17 MeV using NaN_3 samples irradiated in the beam of the 25 MeV betatron at Tohoku University. β^+ activity was measured with a scintillation counter set to the annihilation peak. The threshold was found to be 11.49 ± 0.05 MeV and there were 7 other breaks in the curve, the first four corresponding to known levels in N^{14}. A.Ashmore

2207 PHOTONUCLEAR STUDIES WITH MONOENERGETIC GAMMA RAYS FROM THERMAL NEUTRON CAPTURE.
R.E.Welsh and D.J.Donahue.
Phys. Rev. (USA), Vol. 121, No. 3, 880-5 (Feb. 1, 1961).
Monoenergetic γ-rays produced when neutrons are captured in various materials were used to study the following reactions: $Ta^{181}(\gamma, n)Ta^{180m}$(8.15 hr), $Au^{197}(\gamma, n)Au^{196}$(5.6 days), $Ho^{165}(\gamma, n)Ho^{164}$(34 min), $Ag^{107}(\gamma, n)Ag^{106}$(24 min), and $Nb^{93}(\gamma, n)Nb^{92}$(10 days). Cross-sections for these reactions were obtained at several discrete energies between 7.5 and 10.8 MeV. Estimates were also made of the thresholds of these reactions. Two of the thresholds so obtained, $Ta^{181}(\gamma, n)Ta^{180m}$, E_t = 7.60 ± 0.08, and $Nb^{93}(\gamma, n)Nb^{92}$, E_t = 8.99 ± 0.04, have precisions comparable with those of previous measurements of the same quantities.

Due to Protons

2208 COMPARISON OF INELASTIC SCATTERING FROM Sm^{152} WITH COULOMB EXCITATION THEORY.
E.M.Bernstein and E.Z.Skurnik.
Phys. Rev. (USA), Vol. 121, No. 3, 841-5 (Feb. 1, 1961).
In order to check the theory of electric quadrupole Coulomb excitation, accurate measurements were made of differential cross-sections for inelastic scattering from the first excited state of Sm^{152}. Protons, deuterons, and alpha-particles of energies in the region of 4 MeV were used as the bombarding particles. In addition to the angular distribution of inelastically scattered deuterons,

measurements were also made with protons at two scattering angles and at a backward angle with deuterons and alpha particles of different incident energies. The data are found to be in excellent agreement with the semiclassical description of the Coulomb excitation process.

2209 NEUTRON EVAPORATION SPECTRA FROM (p, n) REACTIONS. R.L.Bramblett and T.W.Bonner.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 395-407 (Nov. (2), 1960).

A new type of neutron spectrometer was used to compare neutron spectra from (p, n) reactions in several medium-weight nuclei with Weisskopf evaporation theory. The method is very sensitive to the shape of the spectrum from 0.1 to 2.0 MeV, and allows the determination of the exponent k and the parameter τ in the expression $E^k e^{-E/\tau}$ for the neutron spectrum. Measurements of the (p, n) spectra from targets of Sn^{120}, Co^{59}, In^{115}, Ag^{109}, Sb^{123}, Nb^{93}, Rh^{103}, Cd^{114} and Sn^{122} were made with a proton bombarding energy of 5.30 MeV. The neutron spectra agree well with that predicted by evaporation theory (k = 1) for all of the reactions studied except Sn^{120}(p, n) and Co^{59}(p, n). The values of τ obtained for the remaining seven target nuclei are respectively 0.53, 0.56, 0.51, 0.57, 0.59, 0.49 and 0.46 MeV, with an estimated absolute error of 0.02 MeV. For those nuclei for which the neutron spectra agree with theory, the variation of the level density parameter with atomic weight is roughly $a \cong 0.094 A\ (MeV)^{-1}$. Angular distributions were obtained for four representative target nuclei. The angular distributions of neutrons from Sn^{120}(p, n) and In^{115}(p, n) were isotropic to within 5%, whereas those from Nb^{93}(p, n) and Co^{59}(p, n) were symmetric about 90° with dips at 90° of 5% for Nb^{93} and 7% for Co^{59}. The angular distributions, in conjunction with information about the neutron spectra at 0° and 135° show that the contribution of direct interaction to these (p, n) cross-sections is less than 5%.

2210 THE OBSERVATION OF $p'-\gamma$ ANGULAR CORRELATION AT A NUCLEAR RESONANCE.
H.Yoshiki and N.M.Nikolic.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 442-7 (Nov. (1), 1960).

The $p'-\gamma$ angular correlation in the $C^{12}(p, p'\gamma)C^{12}$ reaction was measured on nuclear resonances between 5.3 MeV and 6.1 MeV of incident proton energy. The excitation curve of this reaction shows a weak resonance at 5.69 MeV, which corresponds to an excitation of 7.17 MeV in N^{13}. The correlation measurements indicate a large departure from the compound theory on the 5.93 MeV resonance.

2211 RADIATIVE CAPTURE OF PROTONS IN C^{13}.
R.E.Hester and W.A.S.Lamb.
Phys. Rev. (USA), Vol. 121, No. 2, 584-6 (Jan. 15, 1961).

An excitation curve of the $C^{13}(p,\gamma)N^{14}$ reaction was measured from 100 to 140 keV. The cross-section ranges from $(7.7 \pm 1.8) \times 10^{-34} cm^2$ at 100 keV to $(9.8 \pm 1.2) \times 10^{-33} cm^2$ at 140 keV. The results are compared with those of previous measurements.

2212 RELATIVE YIELDS OF NEUTRON GROUPS FROM THE Li^7(p, n)Be^7,Be^{7*} REACTIONS.
P.R.Bevington, W.W.Rolland and H.W.Lewis.
Phys. Rev. (USA), Vol. 121, No. 3, 871-6 (Feb. 1, 1961).

The relative yields of the two groups of neutrons from this reaction, leading to the ground state and the 430 keV state of Be^7, were measured with a time-of-flight system, using pre-acceleration pulsing of the accelerator beam. Data were taken at 30° intervals between 0° and 150° for proton energies high enough to produce (p, n') neutrons above the detection threshold (300 keV). Since the yield of the (p, n) reaction is more highly peaked in the forward direction than that of the (p, n') reaction, the ratio of the (p, n') to (p, n) intensities grows with increasing angle, severly limiting the usefulness of the (p, n) reaction as a neutron source above the (p, n') threshold at back angles. Absolute differential and total cross-sections for both groups were calculated from the data. A comparison with theory for total cross-sections and angular distributions suggests the existence of three previously unidentified levels in Be^8. One level, with $J^\pi = 1^-$, near the threshold for the (p, n') reaction, is responsible for the fast rise in the (p, n') total cross-section near threshold. A second level, corresponding to an incident proton energy of about 3.0 MeV, does not contribute significantly to the yield of the (p, n') reaction; the data are consistent with an assignment of $J^\pi = 1^+$ and a total width of 1 MeV. The bulk of the total cross-section curve for the (p, n') reaction was fitted by assuming a 1^+ level corresponding to an incident proton energy of 3.5 MeV, with $\gamma_n^2 \cong \gamma_p^2$, $\gamma_{n'}^2 \cong 5\gamma_p^2$, and $\gamma_{p'}^2 \ll \gamma_p^2$.

AN INVESTIGATION OF PROPERTIES OF THIN LITHIUM FILMS BY USE OF THE Li^7(p, n)Be^7 REACTION. See Abstr. 1454

ABSOLUTE MEASUREMENT OF γ-QUANTA FROM Li^7(p, γ)Be^8. See Abstr. 2028

2213 INVERSE PHOTONUCLEAR REACTIONS $N^{14}(p,\gamma)O^{15}$ AND $N^{15}(p,\gamma)O^{16}$ IN THE REGION OF THE GIANT RESONANCE. S.G.Cohen, P.S.Fisher and E.K.Warburton.
Phys. Rev. (USA), Vol. 121, No. 3, 858-65 (Feb. 1, 1961).

The 90° yield of γ-rays to the O^{15} ground state from the $N^{14}(p,\gamma)O^{15}$ reaction was measured for proton energies between 12 and 19.5 MeV, covering the region of excitation in O^{15} between 18 and 25 MeV. The excitation curve is quite flat (with $d\sigma/d\Omega$ at 90° $\cong$ 16 $\mu b/4\pi$ sr), and shows little evidence of the giant resonance. The results for O^{15} are compared to those for N^{15} obtained by Jacobs and Stephens by means of the $N^{15}(\gamma, p)C^{14}$ reaction. The 90° yield of γ-rays to the O^{16} ground state from the $N^{15}(p,\gamma)O^{16}$ reaction was measured for proton energies between 10 and 15 MeV, corresponding to O^{16} excitation energies between 21 and 26 MeV. The excitation curve shows two large resonances peaked at 21.8 and 24.7 MeV with integral total cross-sections of about 0.27 MeV mb each if no background is assumed. The O^{16} results are compared to theoretical calculations of Elliott and Flowers and of others.

2214 EVIDENCE FOR COMPOUND NUCLEUS FORMATION USING (p,p') AND (α,p) SCATTERING IN NICKEL.
R.Fox and R.D.Albert.
Phys. Rev. (USA), Vol. 121, No. 2, 587-91 (Jan. 15, 1961).

Spectra for (p,p') and (α,p) reactions were obtained by bombarding nickel targets with the beam of the Livermore 90 in. cyclotron and magnetically analysing protons emitted at 135°. These reactions were studied for several energies of incident protons between 7.8 and 11.4 MeV, and incident alphas between 9.65 and 12.8 MeV. When the differential scattering cross-section is divided by the emitted channel energy and the black nucleus cross-section for protons, results are obtained for different incident proton energies which have the same relative shape when plotted versus excitation energy. This is strong evidence for formation of compound nuclei in these reactions. A large peak is observed in the spectrum at 4.75 MeV, an excitation energy where the level density is sufficiently high that it is difficult to atribute this peak to a single level. An anomalous peak at about this energy was previously observed for 23 MeV (p,p') scattering and 30 MeV (α,α') scattering on nickel targets by Cohen, and Sweetman and Wall. Results obtained for the (α,p) spectrum are in good agreement with predictions of the statistical model of the compound nucleus assuming a level density of the form $\exp[2(aE)^{1/2}]$.

2215 CROSS-SECTION FOR THE FORMATION OF Pa^{227} IN THE SPALLATION OF THORIUM BY 155 MeV PROTONS. G.Boussières, M. Hussonnois, M.Lefort, Y.Legoux, G.Simonoff and X.Tarrago.
C.R. Acad. Sci. (France), Vol. 251, No. 20, 2155-6 (Nov. 14, 1960). In French.

Two methods were used to obtain the cross-section for the reaction Th^{232}(p, 6n)Pa^{227}, one in the external, the other in the internal beam. The values obtained were 1.4 ± 0.2 mb and 1.5 ± 0.2 mb. These are much lower than that obtained by Meinke et al. [Journal of Inorganic and Nuclear Chemistry (GB), Vol. 3, 69 (1956)].

A.Ashmore

Due to Neutrons

2216 POTENTIAL SCATTERING OF NEUTRONS IN THE RESONANCE REGION.
W.Ratyński, J.Turkiewicz and P.Zuprański.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 8, 527-9 (1959).

Transmission measurements were made with samples of Al, Bi in the neutron beam of the EWA reactor operating at a power of 2 MW. The detector was a BF_3 counter at a pressure of 600 mm Hg. Al and Bi showed straight-line log plots for transmissions from

to 0.1, whereas Ag showed the characteristic deviation for transitions above 0.02. The cross-sections obtained were:

Al 1.4 ± 0.1 barn,
Ag 5.3 ± 0.4 barn,
Bi 8.9 ± 0.4 barn.

A.Ashmore

2217 SPIN–ORBIT EFFECTS IN THE INELASTIC SCATTERING OF 12 MeV NEUTRONS IN CARBON.
.Robson and D.Robson.
c. Phys. Soc. (GB), Vol. 76, Pt 5, 611-22 (Nov., 1960).
The angular distribution and polarization of elastic and inelastic ttering of 12 MeV neutrons on carbon were investigated using the orted-wave approximation, assuming direct interaction in intic collisions. The introduction of a spin–orbit potential oled the same optical parameters to describe the elastic and astic scattering. Calculations were performed for spin-indedent potentials and the results compared with those of Levinson Banerjee (1958). It was found that the neglect of a spin–orbit ential led to inconsistent optical-model parameters and poor at intermediate angles. The inelastic polarization predicted similar to the elastic polarization in the outgoing channel, ough it was slightly smaller. Even larger discrepancies were d in the two-body potential when a spin–orbit potential was inled. Extension of the theory to include collective motion may be essary.

2218 POTENTIAL SCATTERING OF NEUTRONS FOR Fe, Co, Ni, Cu, Zn, Se.
atyński, J.Turkiewicz and P.Zuprański.
. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), 8, No. 2, 117-18 (1960).
Cross-sections, obtained by transmission measurements, give ear radii which are not in agreement with the optical model for erical nuclei. There is quite good agreement with the calcula- of Chase, Wilets and Edmonds (Abstr. 5390 of 1958) which lves strong deformations of the nuclear surface. A.Ashmore

219 SLOW-NEUTRON SCATTERING CROSS SECTIONS OF TERBIUM, YTTERBIUM, AND LUTETIUM. M.Atoji.
s. Rev. (USA), Vol. 121, No. 2, 610-12 (Jan. 15, 1961).
The coherent neutron scattering cross-sections of Tb, Yb, and s determined from the neutron diffraction measurements on , YbC_2, Yb, and Lu metals are found to be 7.2 ± 0.4, 20.0 ± 0.4, 3.70 ± 0.37 barns, respectively, all with amplitude of positive e. The total scattering cross-sections of Tb, Yb, and Lu and nagnetic scattering cross-sections of Tb^{3+} and Yb^{3+} are evaed for thermal neutron energies. The neutron diffraction data show the Debye temperatures of Yb and Lu metals to be ± 5° and 161 ± 7° K, respectively.

220 $Al^{27}(n,\alpha)Na^{24}$ CROSS-SECTION AS A FUNCTION OF NEUTRON ENERGY. H.W.Schmitt and J.Halperin.
. Rev. (USA), Vol. 121, No. 3, 827-30 (Feb. 1, 1961).
The cross-section was measured as a function of neutron gy in the range $6.1 \leq E_n \leq 8.3$ MeV and at 14.8 MeV. Measures were made relative to the fission cross-section of U^{238}; activn techniques were used to determine the number of $Al^{27}(n,\alpha)$ s. While a number of peaks and valleys appear in the crossn versus energy curve, there is a general increase in crossn with increasing energy consistent with the Coulomb penetra- of the alpha particle.

221 GAMMA-RAYS FROM THE INTERACTION OF 14 MeV NEUTRONS WITH CARBON.
veniste, A.C.Mitchell C.D.Schrader and J.H.Zenger.
ar Phys. (Internat.), Vol. 19, No. 4, 448-52 (Nov. (1), 1960).
The cross-section for the $C^{12}(n,n')C^{12} \rightarrow C^{12} + \gamma$ (4.43 MeV) ion was measured near 14 MeV by detecting the gamma-rays attering angles of 30° to 150°. A time-of-flight technique was to distinguish the gamma-rays from the high neutron back- d. A least-squares fit to the data gives

$$(\theta) = (13.3 \pm 0.6) + (40.0 \pm 4.7)\cos^2\theta - (34.1 \pm 5.1)\cos^4\theta$$

e angular distribution. The integrated cross-section is = 249 ± 28 mb.

2222 DIRECT CAPTURE OF SLOW NEUTRONS BY THE NUCLEAR p STATES. H.Morinaga and C.Ishii.
Progr. theor. Phys. (Japan), Vol. 23, No. 1, 161-7 (Jan., 1960).
Cross-sections for the capture of a slow neutron by unfilled bound p states are calculated with the p-state wave-functions and slow-neutron wave-functions for a square well and a Woods–Saxon type potential in the case of Ca^{40}. The results are in good agreement with experiment. This suggests the possibility of obtaining minimum possible neutron cross-sections for nuclei with given A. Also, neutron cross-sections may give a sensitive test of nuclear potentials.

2223 ABSOLUTE NEUTRON ABSORPTION CROSS-SECTIONS FOR Sb–Be PHOTONEUTRONS.
H.W.Schmitt and C.W.Cook.
Nuclear Phys. (Internat.),Vol. 20, No. 2, 202-19 (Oct. 4, 1960).
Absolute absorption cross-sections of Cu, Zn, Ag, Cd, In, Sb, I, Au, Hg and Pb were measured for Sb–Be photoneutrons, the average energy of which is given as 24.0 ± 2.2 keV. A specially designed antimony–beryllium neutron source was used in spherical shell transmission measurements. A detailed account of the method, including discussion of the experimental measurements and analysis of data is given. Absorption cross-sections obtained are as follows: Cu, 42 ± 15 mb; Zn, 64 ± 20 mb; Ag, 1185 ± 80 mb; Cd, 515 ± 70 mb; In, 823 ± 60 mb; Sb, 565 ± 45 mb; I, 885 ± 90 mb; Au, 585 ± 60 mb; Hg, 380 ± 100 mb; Pb, 3 ± 9 mb.

2224 THERMAL AND RESONANCE NEUTRON-CAPTURE GAMMA-RAYS FROM Nd^{144} AND Nd^{146}.
J.E.Draper and R.L.Hickok.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 436-41 (Nov. (1), 1960).
A number of neutron-capture gamma-rays following thermal and resonance neutron capture forming Nd^{144} and Nd^{146} were investigated in the gamma-ray energy range below 1 MeV. Absolute intensities and isotopic assignments are reported.

2225 THE $O^{16}(n,\alpha)C^{13}$ REACTION BY THE THIN CRYSTAL METHOD. N.Cindro, I.Šlaus, P.Tomaš and B.Eman.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 96-100 (Jan., 1961).
The angular distribution of the $O^{16}(n,\alpha)C^{13}$ reaction with 14.4 MeV neutrons was measured by using a thin crystal, whose thickness was enough to stop alpha-particles of a given energy. Thus the use of the telescopic arrangement was avoided. The results show a prounounced backward peaking. A theoretical fit using the "heavy particle stripping" formulae is attempted.

2226 (n, α) AND (n, p) REACTIONS IN Na^{23}.
L.Varga.
Nuclear Phys. (Internat.), Vol. 20, No. 3, 487-90 (Nov. (2), 1960).
From the decay curve of the radioactive nuclei produced in the (n, α) and (n, p) reactions occurring in a NaI:Tl scintillation crystal irradiated by neutrons of 14 MeV energy, the ratio $\sigma(n,\alpha)/\sigma(n,p)$ of the Na^{23} nucleus was computed and found to be 2.4 ± 10% as compared with 3.1 obtained from the evaporation theory.

2227 SOME REMARKS ON THE RADIATIONS RECORDED IN ILFORD D_1 AND K_0 EMULSIONS DURING THEIR EXPOSURE TO 14 MeV NEUTRON GENERATORS. M.Ader.
J. Phys. Radium (France), Vol. 19, No. 11, 913 (Nov., 1958).
In French,
D_1 and K_0 emulsions, specially treated to record protons of a few MeV, were exposed to 14 MeV neutrons. Some reactions produced single α-particles with energies up to 17 MeV. E.J.Burge

DETERMINATION OF LEVELS IN V^{51-2} FROM THE γ-RAYS FROM THERMAL-NEUTRON CAPTURE. See Abstr. 2173

Due to Deuterons

2228 THE ELASTIC SCATTERING OF 19.5 MeV DEUTERONS BY KRYPTON.
P.E.Hodgson, J.Aguilar, A.García and J.B.A.England.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 138-44 (Jan., 1961).
Elastic differential cross-sections were measured in the range 13° to 90° in the c.m. system using a nuclear emulsion plate camera.

The results are compared with calculations based on the optical model of the interaction.

2229 POLARIZATION IN (d, p) REACTIONS.
D.Robson.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 34-46 (Jan., 1961).

Previous treatments of the distorted wave theory in stripping are extended to include the effects of spin–orbit forces in both incident and final channels. Numerical calculations of the $C^{12}(d,p)C^{13}$ ground-state reaction at 8.9 MeV incident energy using rounded optical model potentials yield the correct sign for the polarization of the emergent protons. The inclusion of spin–orbit forces in both channels relieves the $33\frac{1}{3}\%$ restriction on the size of the polarization. Polarizations as large as 70% are predicted in this way and provide a likely explanation of the large experimental polarizations. The distorted wave-functions used to describe the stripping reaction are also used to predict elastic scattering angular distributions and polarizations. Good agreement is found with experiment in cases where data are available.

2230 SPIN–ORBIT EFFECTS IN THE STRIPPING REACTION INVOLVING POLARIZED PARTICLES. D.Robson.
Nuclear Phys. (Internat.), Vol. 22, No. 1, 47-56 (Jan., 1961).

The theory of the stripping reaction involving polarized particles is considered. The angular distribution and polarization of the produce of the stripping reaction induced by polarized particles in unpolarized nuclei are determined by the distorted wave method including spin–orbit coupling. An attempt is made to investigate the validity of stripping formulae in which spin–orbit effects are neglected.

2231 COMPARISON OF THE REACTIONS $A^{36}(d,p)A^{37}$ AND $A^{36}(d,n)K^{37}$. S.S.Yamamoto and F.E.Steigert.
Phys. Rev. (USA), Vol. 121, No. 2, 600-5 (Jan. 15, 1961).

These mirror reactions were studied at 3.85 MeV bombarding energy. In the first, Q values of 6.55, 5.16, 4.92, 3.98. and 3.00 MeV were observed. The stripping distributions may be desribed in terms of l_n values of 2, 0, 2, 2, and 2, respectively. In the second, Q values of −0.32 and −1.78 MeV were observed. The former followed an $l_p = 2$ angular distribution. The latter could be described by a sum of $l_p = 0$ and $l_p = 2$ distributions, suggesting an unresolved doublet.

2232 GAMMA-RAY CORRELATIONS FROM THE REACTION $B^{10}(d,p)B^{11}$. W.Reichelt and G.E.Owen. .
Phys. Rev. (USA), Vol. 121, No. 2, 547-52 (Jan. 15, 1961).

The $B^{10}(d,p)B^{11}$ reaction was studied at a deuteron bombarding energy of 1.2 MeV. Angular distributions and proton–gamma correlations associated with transitions to the first and second excited states of B^{11} were obtained. An analysis including the effects of heavy-particle stripping was performed for the first excited state transition and is consistent with the observed distribution and correlation.

2233 DEUTERON STRIPPING AND PICKUP REACTIONS IN OXYGEN-16. E.L.Keller.
Phys. Rev. (USA), Vol. 121, No. 3, 820-4 (Feb. 1, 1961).

The reactions $O^{16}(d,p)O^{17}$ and $O^{16}(d,t)O^{15}$ were studied by bombarding thin nickel oxide foils with 15 MeV deuterons from a cyclotron. The reaction particles were magnetically analysed and detected either by nuclear emulsions or by a CsI(Tl) scintillator. Angular distributions and absolute cross-sections were obtained for the first six states of O^{17} and for the ground state of O^{15}. Reduced widths having values $\Theta^2 = 0.045$, 0.16, 0.0024, 0.0024, 0.0071, 0.047, and 0.012, respectively, were extracted from a comparison of the data with the predictions of Butler stripping theory. The most notable results of the (d,p) experiment indicate that: (1) the $\frac{7}{2}^-$ state at 3.846 MeV does not appear to be a good $1f_{7/2}$ single-particle state, (2) the $2p_{3/2}$ single-particle component seems to be fragmented over more than two states, and (3) the $\frac{1}{2}^-$ state at 3.058 MeV contains a $2p_{1/2}$ single-particle component. The results of the (d,t) experiment suggest a dependence of the 1p single-particle reduced width on Q-value.

2234 (d,p) REACTION ON HEAVY ELEMENTS AT LOW DEUTERON ENERGIES. R.H.Stokes.
Phys. Rev. (USA), Vol. 121, No. 2, 613-18 (Jan. 15, 1961).

Deuterons of 9.1, 8.3 and 7.4 MeV were used to produce (d,p) reactions in Pb^{208} and Bi^{209} targets. The proton differential cross-section was measured for different Q values, each of which corresponds to a final state of known assignment. With one exception, all of the observed angular distributions were broad peaks with maxima near 180°. The theoretical approximations which apply for low deuteron energy predict a Gaussian distribution peaked in the backward direction. Although the measured distributions are not of Gaussian form, a comparison of the measured and predicted width variation with Q shows fair agreement with one theoretical result and poor agreement with the other. For the reaction with the highest Q(≅4.5 MeV) a peak near 120° was observed. This more forward peak would be expected both from a reduced Coulomb effect and from the influence of the nuclear potential on the proton. As expected when the Coulomb field is dominant, there was only a small observed correlation between the measured angular distribution and the angular momentum of the captured neutron. In a few cases, triton angular distributions from (d,t) reactions were measured, and these also showed peaks at large scattering angles.

2235 REACTION MECHANISM STUDIES ON $Si^{28}(d,p)Si^{29}$. I. DISTORTED WAVE EFFECTS.
J.A.Kuehner, E.Almqvist and D.A.Bromley.
Nuclear Phys. (Internat.), Vol. 19, No. 6, 614-33 (Dec. (2), 1960).

A study of the (p,γ) angular correlations involving the 1.28 and 2.03 MeV states in Si^{29} populated by the $Si^{28}(d,p)Si^{29}$ reaction was carried out for deuteron energies in the range from 6 to 9 MeV. In each case measurements were carried out in the (d,p) reaction plane with protons detected on the observed peak of the $l_n = 2$ stripping angular correlation. These data were analysed within the framework of distorted-wave stripping formalism. The measurements on the 2.03 MeV state alone enable the statistical tensors for the reaction to be determined for each incident deuteron energy. These statistical tensors were then used to compute the angular correlation of the 1.28 MeV radiation, yielding results in good agreement with the experimental measurements and thus supporting the expectation that the matrix elements are essentially independent of the detailed nuclear structure of the final state. The statistical tensors were also used to predict the general (p,γ) angular correlation function over the sphere as well as the magnitude of the proton polarization for the Si^{29*}-proton systems involving both the 1.28 MeV and 2.03 MeV excited states.

2236 γ-RAYS PRODUCED BY THE BOMBARDMENT OF Be^9 BY DEUTERONS OF 2 TO 5.6 MeV.
M.Suffert, D.Magnac-Valette and J.Yoccoz.
C.R. Acad. Sci. (France), Vol. 251, No. 21, 2335-7 (Nov. 21, 196
In French.

The γ-rays were detected in a 4 in. NaI crystal at 90° from the incident beam direction. The spectrum showed two equally intense peaks, one corresponding to the excitation energy and the other 2.2 MeV lower. The excitation curve is given for the higher peaks and shows a decrease to $\sim \frac{1}{2}$ at the highest energy.

A. Ashm

Due to Alpha-particles

2237 ^{3}He INDUCED REACTIONS.
D.A.Bromley and E.Almqvist.
Rep. Progr. Phys. (GB), Vol. 23, 545-629 (1960).

Reviews the results obtained from studies of He^3-induced nuclear reactions prior to June 1959. Following a brief historical survey including range–energy, energy loss, and stopping power data as well as a reaction Q-value tabulation, the experimental results are first presented in terms of their relevance to determination of the reaction mechanisms involved; this is followed by a discussion of the use of He^3 in nuclear spectroscopy. The next section is devoted to summarizing available He^3 reaction data according to target nuclei involved. Numerous figures illustrating excitation curves, spectra and angular distributions are included. The report concludes with a short section devoted to suggested experiments which emphasize the very great scope remaining for experimental work with low-energy He^3 accelerators. A comprehensive bibliography covering publications on He^3 reactions prior to June 1959, and including selected papers on experimental techniques as well as on the production and handling of He^3 in accelerators, is appended.

2238 A STUDY OF THE $^{27}Al(^3He, d)^{28}Si$ REACTION.
S.Hinds and R.Middleton.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 545-52 (Oct. 1, 1960).

The energy levels of Si^{28} were determined below an excitation gy of 10.37 MeV by magnetic analysis of the deuterons from the $(He^3, d)Si^{28}$ reaction. Angular distributions of several deuteron ups were measured at incident energies of 5.7 and 9.16 MeV and n a comparison with stripping theory, certain *l*-value assignments e made. Evidence is presented favouring the 9.314 and 9 MeV levels being respectively the first and second T = 1 es of Si^{28}.

2239 THE SCATTERING OF ALPHA PARTICLES AND DEUTERONS BY IODINE-127.
Van Heerden and D.J.Prowse.
lear Phys. (Internat.), Vol. 19, No. 6, 589-603 (Dec. (2), 1960).
The differential elastic scattering cross sections of 38 MeV articles as well as 8 and 19.5 MeV deuterons by I^{127} were deter-ed using nuclear emulsions. The angular distributions obtained e analysed according to Porter's model of absorption along sical undistorted Coulomb orbits. Information was thus obtained he mean free path of the incident particles in nuclear matter. In course of this experimental work, indications of the existence of hen peak in the inelastic scattering were observed; the evidence escribed and the implications are discussed.

2240 PROTON GROUPS FROM THE $F^{19}(\alpha, p)Ne^{22}$ REACTION AND THE $Ca^{40}(\alpha, p)Sc^{43}$ REACTION.
Martin, M.B.Sampson and D.W.Miller.
s. Rev. (USA), Vol. 121, No. 3, 877 (Feb. 1, 1961).
A CaF_2 target was bombarded with 21.9 MeV alpha particles and energies of the outgoing protons were measured with a magnetic ctrometer. Proton groups leading to energy levels in Ne^{22} at tation energies of 0, 1.28, 3.37, 4.52, 5.18, 5.67, 6.41, 6.88, and MeV were seen. The ground-state Q-value for the $Ca^{40}(\alpha,p)Sc^{43}$ tion was found to be -3.47 ± 0.030 MeV. Some information about olute cross-sections and angular distributions for the fluorine and ium reactions is also presented.

2241 ALPHA EXCITATION FUNCTIONS OF IRON-54.
S.Tanaka, M.Furukawa, M.Yagi, S.Iwata and H.Amano.
hys. Soc. Japan, Vol. 14, No. 9, 1251 (Sept., 1959).
Using the stacked foil technique with the 32 MeV α-particle n of the INS cyclotron, excitation functions were obtained for reactions $Fe^{54}(\alpha,n)Ni^{57}$, $Fe^{54}(\alpha,p)Co^{57}$, $Fe^{54}(\alpha,2n)Ni^{56}$, and $(\alpha,pn)Co^{56}$. A.Ashmore

e to other Particles and Nuclei

2242 EXCITATION CURVES AND CROSS-SECTIONS OF THE REACTIONS Li(t,n) FROM 100 TO 300 keV.
ltz and D.Magnac-Valette.
Acad. Sci. (France), Vol. 251, No. 19, 2006-8 (Nov. 7, 1960).
rench.
The yields of the reactions Li(t,n) at low energy, between 100 300 keV, were measured using a 300 kV accelerator and a n trifluoride proportional counter. Previously the lowest gy results were those of Crews (Abstr. 6459 of 1951) at 250 keV. variation of the cross-section of Li^6(t,n) is monotonic whilst ,n) shows a resonance at 240 keV. J.D.Dowell

2243 COULOMB EXCITATION OF THE FIRST LEVELS OF SPHERICAL EVEN NUCLEI BY MULTIPLY CHARGED
. D.S.Andreyev, A.P.Grinberg, K.I.Erokhina and I.Kh.Lemberg.
ear Phys. (Internat.), Vol. 19, No. 4, 400-25 (Nov. (1), 1960).
The Coulomb excitation of the first excited levels in the nuclei e^{20}, Ne^{22}, Mg^{24}, Si^{28}, Ti^{46}, Ti^{48}, Cr^{54}, Ni^{60}, Ni^{62}, Ni^{64}, $Zn^{64,66,68}$, Se^{76}, Se^{80}, Se^{82} and $Zr^{92,94}$ was investigated by means of the otron-accelerated multiply charged ions of $N^{14;3+}$ (E = 16.3 MeV), $^{+}$ (26 and 36 MeV), $O^{16;4+}$ (18.2 MeV), $Ne^{20;4+}$ (23.1 and 27.9 MeV) $Ne^{22;4+}$ (25.2 MeV). In the first two cases the nuclei investigated present not in the target, but in the incident particle beam. lifetime of the first excited level was determined for all nuclei. ts and difficulties in using muliply charged ions for the investi-n of Coulomb excitation are discussed.

2244 RANGES AND RANGE STRAGGLING OF Tb^{149}, At and Po. L.Winsberg and J.M.Alexander.
. Rev. (USA), Vol. 121, No. 2, 518-28 (Jan. 15, 1961).
Reports a study of ranges and range straggling of recoils from nuclear reactions induced by the ions C^{12}, N^{14}, O^{16}, O^{18}, and N^{22} with kinetic energies of 10 MeV per nucleon and less. Range-energy curves were obtained for Tb^{149} (recoil energies of 4 to 29 MeV) in Al, for At and Po (4 to 15 MeV) in Al, and for At and Po (4 to 9 MeV) in Au. Ranges of Tb^{149} at the threshold of each reaction were obtained by extrapolation. The agreement of these and the directly measured values supports the assumption of compound-nucleus formation used in calculating the recoil energies. The smaller recoil velocities in this study are of the same order as the Bohr velocity (2.2×10^8 cm/sec). The values of the average range and the straggling parameter are compared with stopping theory. The contribution to the measured range straggling from the nuclear reaction is discussed. These results and the work of others are used to obtain values of the range for Xe^{139} in Al from 0.1 to 70 MeV and for At^{203} in Au from 0.01 to 10 MeV. See also following abstract.

2245 RECOIL STUDIES OF NUCLEAR REACTIONS INDUCED BY HEAVY IONS. J.M.Alexander and L.Winsberg.
Phys. Rev. (USA), Vol. 121, No. 2, 529-37 (Jan. 15, 1961).
The mechanism of nuclear reactions induced by heavy ions was investigated by measuring the recoil ranges of Tb^{149}, At^{211} and other alpha-emitting isotopes of At and neighbouring elements and by determining the cross-sections for the formation of Tb^{149} and At^{211}. Recoil ranges were consistent with compound-nucleus formation at all energies studied for the following reactions: $Pr^{141}(C^{12}, 4n)Tb^{149}$, $Ce(N^{14}, xn)Tb^{149}$, $La^{139}(O^{16}, 6n)Tb^{149}$, $La^{139}(O^{18}, 8n)Tb^{149}$, and $Ba(Ne^{22}, pxn)Tb^{149}$. A similar result was obtained for the reaction $Pr^{141}(O^{16}, 2p6n)Tb^{149}$ at 138 and at 146 MeV and for the reactions $Au^{197}(O^{16}$, 2pxn and 3pxn)At,Po at energies below 100 MeV. The excitation functions of the (HI,xn)Tb^{149} reactions HI = heavy ion seem to be characteristic of an evaporation process but have smaller peak cross-sections than do the excitation functions of the reactions $Ba(Ne^{22}, pxn)Tb^{141}$ or $Pr^{141}(O^{16}, 2p6n)Tb^{149}$. It is concluded that most reactions probably involve charged-particle emission. The reaction $Ba(Ne^{22}, pxn)Tb^{149}$ seems to occur with much greater probability than the reaction $Ba(Ne^{20}, pxn)Tb^{149}$. In many cases the compound-nucleus mechanism cannot account for the results. Partial momentum transfer is observed in the reactions $Au^{197}(O^{16}$, 2pxn and 3 pxn)At,Po at energies above 100 MeV. Partial momentum transfer also occurs when Bi is bombarded at energies 1.3 times the barrier energy or greater. Reactions of Bi with heavy ions (Ne^{20} is possible exception) at energies near the Coulomb barrier produce At^{211} with greater recoil energy than expected from a compound-nucleus mechanism. Apparently, particles are emitted in the backward direction. Near the barrier the cross-section for the production of At^{211} by C^{12}, O^{16}, and Ne^{20} bombardment comprises about $\frac{1}{4}$ the value calculated for compound-nucleus formation. Therefore, the cross-section for all noncompound-nucleus reactions must comprise a large fraction of the total interaction cross-section. The experiments with Pb as a target are also consistent with this conclusion.

Nuclear Fission

2246 NEW TECHNIQUE FOR THE DIRECT INVESTIGATION OF FISSION EVENTS.
J.J.Kelsch, O.F.Kammerer and P.A.Buhl.
Brit. J. appl. Phys., Vol. 11, No. 12, 555 (Dec., 1960).
A sandwich consisting of two 50A layers of pure aluminium around a 10A layer of U^{235} is constructed by evaporation on the cleavage face of a NaCl crystal. After irradiation by 2.8×10^{15} neutrons per cm^2, the sandwich is floated off. Electron micrographs at a magnification of 140 000 show tracks of 100 A average width and 100 to 20 000 A length, believed to be due to vaporization of aluminium atoms by fission fragments. D.W.L.Sprung

2247 DETECTION OF NEUTRON AND PHOTON INDUCED FISSION BY ZnS(Ag) MIXED WITH URANIUM AND THORIUM COMPOUNDS. N.Mitrofanov and J.J.Van Loef.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 63-6 (April, 1960).
A description is given of a scintillator consisting of ZnS(Ag) mixed with uranium and thorium compounds. The absolute counting efficiency for fast neutron fission is $(3.2 \pm 0.6) \times 10^{-3}$% in the case of an uranium, and $(5.4 \pm 1.0) \times 10^{-3}$% in the case of a thorium compound mixture. The efficiency is within the experimental error independent of the neutron energy between 2 and 3.6 MeV. The

scintillator is shown to be useful for photofission studies due to its very low sensitivity for γ rays.

2248 ANGULAR DISTRIBUTIONS IN PHOTOFISSION OF URANIUM. B.Forkman and S.A.E.Johansson.
Nuclear Phys. (Internat.), Vol. 20, No. 2, 136-54 (Oct.(4), 1960).

The angular distributions in photofission of natural uranium were measured. Bremsstrahlung with maximum energies of 10 and 20 MeV and monoenergetic gamma-radiation of 6.1, 6.9 and 7.1 MeV energy were used as photon sources. The fission fragments were detected in two ways. One method was to irradiate nuclear emulsions containing uranium. In the other method a scintillation counter was used to detect the fission fragments. The first method is more tedious but has a considerably better angular resolution. The two methods give results which agree very well. The following results were obtained. The angular distribution at 6.1 MeV is of the form $0.07 + \sin^2\theta + 0.37 \sin^2 2\theta$. At 6.9 MeV the distribution $1 + 0.70 \sin^2\theta + 0.05 \sin^2 2\theta$ was obtained. The distribution at 7.1 MeV is similar but somewhat more isotropic. The angular distribution obtained by 10 MeV bremsstrahlung is of the form $1 + 0.85 \sin^2\theta + 0.13 \sin^2 2\theta$. Irradiation with 20 MeV bremsstrahlung gives an isotropic angular distribution. The results of the present work are compared with the theory of A.Bohr. They agree very well with this theory. It is also possible to use these results to separate the photonuclear absorption at 6 MeV into a dipole and a quadrupole part. The quadrupole absorption in particular is discussed and compared with theoretical estimates.

2249 DIRECT PROCESSES AND COLLECTIVE EFFECTS IN HIGH ENERGY PROTON INDUCED FISSION.
H.Faissner and H.Schneider.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 346-65 (Nov. (1), 1960).

Nuclear emulsions loaded with thorium were exposed to the external 600 MeV proton beam of the CERN synchrocyclotron. For each fission event both ranges, a characteristic angle relative to the proton beam and the angle between the two fragments, were measured. From these data one computes, under certain assumptions, the longitudinal momentum imparted to the fissioning nucleus. The distribution of momentum transfers obtained falls off exponentially towards higher values; its maximum is estimated to lie around 170 MeV/c. At momentum transfers above 300 MeV/c the light fragment is emitted preferentially in the forward direction. This indicates the existence of a direct, fast fission mode. The fore–aft asymmetry is largest for fissions almost parallel to the proton beam; it increases with increasing momentum transfer. The range distribution is symmetric. Qualitatively the fast fission may be described as a deformation of a viscous liquid drop by the fast cascade. At momentum transfers below 300 MeV/c there is no significant fore–aft asymmetry. The angular distribution, instead, is peaked around 90^0 to the primary direction. It can be represented by $1 + \alpha \sin^2\theta$ with $\alpha = 0.64 \pm 0.10$. The range distribution has an asymmetric component. Angular anisotropy and mass asymmetric are consistent with the model of Halpern who assumes a collective rotation initiated by the capture of slow secondary nucleons.

2250 FORE–AFT YIELDS OF FRAGMENTS FROM 14 MeV NEUTRON-INDUCED FISSION.
R.B.Leachman and G.P.Ford.
Nuclear Phys. (Internat.), Vol. 19, No. 4, 366-9 (Nov. (1), 1960).

The yield of Zr^{97} and Ba^{139} fission fragments in the direction of 14 MeV neutrons inducing fission of Np^{237} and U^{235} was measured relative to the yield in the opposite direction. The fore–aft isotropy found from these measurements agreed with the compound nucleus theory of fission.

DETECTION OF NEUTRON AND PHOTON INDUCED FISSION BY ZnS(Ag) MIXED WITH URANIUM AND THORIUM COMPOUNDS.
See Abstr. 2247

NUCLEAR POWER STUDIES

2251 NUCLEAR CANADA.
Nucleonics (USA), Vol. 18, No. 10 (Oct., 1960).

A series of articles reviewing Canada's nuclear energy programme. The history and present organization is first discussed and the economic background leading to the construction of the Douglas Point Generating Station (CANDU) explained. All the Canadian programme is based on natural uranium D_2O-moderated reactors. CANDU is a 700 MW(H) 200 MW(E) pressurized D_2O-cooled reactor. The fuel elements are bundles of cylindrical Zirc-alloy-4 tubes containing sintered UO_2 pellets. The excess reactivity for a full natural uranium loaded core at operating temperature is calculated to be 5% $\Delta K/K$. Fuel development has included irradiation measurements, thermal conductivity and fuel sheath interface experiments and determination of mechanical properties of the fuel. The on-power refuelling scheme is described. Abstracts of some of the papers will be found in this or succeeding issues of Physics Abstracts. R.D.Smith

2252 REACTIVITY LIFE OF NATURAL U.
A.G.Ward.
Nucleonics (USA), Vol. 18, No. 10, 69-72 (Oct., 1960).

Data required in estimating reactivity changes due to burn-up in a heavy-water natural Uranium reactor include: short-term reactivity effects of high-power operation [e.g. Xe^{135} poisoning]; moderator temperature coefficient; fuel temperature coefficient; Pu^{239} hold-up as Np^{239}; accurate estimates of changes in isotopic concentration of the fuel, and the effects of the long-term accumulation of low-cross-section fission products. Present experimental data are reviewed and a method of estimating the low-cross-section fission product poisoning effect using three "pseudo fission products" is described. The data and calculations confirm the predicted 9750 MWd/tonne fuel life for the CANDU reactor. R.D.Smith

2253 REACTOR SAFETY IN CANADA.
G.C.Laurence.
Nucleonics (USA), Vol. 18, No. 10, 73-7 (Oct., 1960).

A quantitative approach to safety based on probability is outlined. An acceptable numerical risk was defined as one better than in other industries. A frequency of accidents less than 10^{-5} per reactor year is required. The probability of dangerous failures in reactivity control systems and the primary coolant system can be reduced to acceptable levels by suitable testing methods and by duplication of safety circuits. R.D.Smith

2254 ORGANIC-COOLED DEUTERIUM MODERATOR REACTORS. I.MacKay.
Nucleonics (USA), Vol. 18, No. 10, 78-80 (Oct., 1960).

Review and description of OCDRE, a 35 MW(H) reactor. The reactor has UO_2 fuel and is controlled by the level of the D_2O moderator. The fuel cladding will be sintered aluminium powder. R.D.Smith

2255 AUTOMATIC CONTROL OF THE EL3 REACTOR. P.Dandurand.
Nuclear Electronics Conference, Paris, 1958. Vol. I. (see Abstr. 12719 of 1960) p. 391-400. In French.

The control has the form $u = A(P_0 - P) - B\rho$, where P_0 is the desired power, P is the measured power, ρ is the reciprocal of the period of the reactor, and A and B are adjustable coefficients. The power is measured by means of an ionization chamber close to the core of the reactor, and linear amplifiers give an output which is a linear function of the neutron flux. The output is compared with a selected fraction of a stabilized voltage, in steps representing 1000 kW steps in power. A vernier arrangement interpolates between the steps. The reactivity is measured by differentiation of the power function. Combination of these quantities gives a signal which is used to control the regulating and compensating rods. W.G.Strip

2256 REALIZATION OF THE CONTROL OF THE G2 REACTOR. C.Di Giacomo.
Nuclear Electronics Conference, Paris, 1958. Vol. I. (see Abstr. 12719 of 1960) p. 401-11. In French.

The error signal $e = -A\delta P - (B/P)(dP/dt)$. The response of the loop consisting of the reactor, error amplifiers, motor, control rods, etc. is studied and the components are described. W.G.Strip

2257 ELECTRONICS IN DETECTORS OF SHEATH RUPTURE. J.Goupil, J P.Graftieaux and J.M.Servent.
lear Electronics Conference, Paris, 1958. Vol. I. (see Abstr. 19 of 1960) p. 413-26. In French.
Rupture of the sheath of a fuel element causes gaseous fission ducts to escape into the coolant (air, etc.). Banks of electrically rated shutters allow samples of the coolant in each channel to tested for radioactivity. For air the detector can be a simple 1. counter, but for other gaseous coolants a disintegration mber is used before the detector. The disintegrating fission ducts yield radioactive ions which pass to the detector. To erve the development of a rupture an evolumeter is used. This npares the activity in a channel with its value at the previous mpling. Voltages representing activities are stored on 25 servo- ven potentiometers, selected by electromagnetic clutches. The lications to particular reactors are described in detail.
W.G.Stripp

2258 CONTROL OF THE MELUSINE REACTOR. P.Jover.
lear Electronics Conference, Paris, 1958. Vol. I. (see Abstr. 19 of 1960) p. 427-33. In French.
The control system comprises four chains of measuring devices registers. The first has a fission chamber, amplifiers, integ- or and register, the second an ionization chamber, with logarith- c circuits giving power and period. The third chain is a linear nier, while the fourth contains a computer which can accept the puts of the other chains and control the regulating rods auto- tically. A number of safety interlocks are briefly described.
W.G.Stripp

2259 DETECTION OF LEAKAGES OF HEAVY WATER IN A REACTOR INTO THE LIGHT WATER OF ITS CHANGERS. C.Julliot, A.Lansiart and D.Nordemann.
lear Electronics Conference, Paris, 1958, Vol. I. (see Abstr. 19 of 1960) p. 435-40. In French.
Describes experimental equipment used with a reactor cooled eavy water, which in turn is cooled by light water. Because γ-ray activity is contributed by various products associated n the heavy water, detection is effected by measuring the total vity of the light water at 4 points, subtracting the background ie from another detector. A sixth channel is provided for cking a suspect channel, the test channel being automatically stituted.
W.G.Stripp

2260 THE PROBLEM OF AUTOMATIC STARTING OF NUCLEAR POWER REACTORS. C.Samuel.
lear Electronics Conference, Paris, 1958, Vol. I. (see Abstr. 19 of 1960) p. 441-6) p. 441-6. In French.
The aim of the study was to devise a system which would make run-up completely automatic except for initiation by the operator first stage is the withdrawal of the regulator rods at constant ed, the actuating motor being controlled by a motor-driven ntiometer. The speed of the potentiometer motor is controlled he temperature measured in the thermal circuit of the reactor this temperature is thus maintained constant. The power is sured by an ionization chamber and a logarithmic amplifier, during the first stage this loop gives a negligible output. When power reaches a level at which the signal from the logarithmic n becomes appreciable, the control passes, without discontinuity constant log derivative mode. Switches enable the operator to the reactor rapidly or to stop the run-up at any stage and check unctioning of all elements of the system.
W.G.Stripp

2261 RECENT PROGRESS IN THE SIMULATION OF NUCLEAR PHENOMENA. P.Braffort.
lear Electronics Conference, Paris, 1958, Vol. II. (see Abstr. 0 of 1960) p. 3-7. In French.
A bibliography of 103 items, in chronological order, dealing simulation of the kinetics and thermodynamics of reactors and rol systems.
W.G.Stripp

2262 THE CONCEPTUAL DESIGN OF A POWER-LIMITING SYSTEM FOR A SODIUM COOLED ATOMIC POWER NT. J.H.Talboy, Jr, E.H.Lemon and R.G.Olsen.
ear Electronics Conference, Paris, 1958, Vol. II. (see Abstr. 0 of 1960) p. 9-18.
Schematic diagrams of the Enrico Fermi reactor and of a e analogue computer which was used to simulate the effects of re of the coolant flow are given. Power limiting operates in three modes, the least drastic being called set-back. In this, the regulating rods are run back into the core at the maximum rate. The second method is called sequential scram, and is used to stop transients due to large positive reactivities or failure of coolant flow. The necessary anti-reactivity is obtained by dropping the safety rods one by one into the core. A conventional scram mode is also provided, but is not described. Time graphs of negative reactivity, power and fuel and coolant temperature, obtained with the computer, are given.
W.G.Stripp

2263 AUTOMATIC CONTROL OF A RESEARCH REACTOR. G.J.R.MacLusky.
Nuclear Electronics Conference, Paris, 1958, Vol. II. (see Abstr. 12720 of 1960) p. 19-27.
Signals from a deviation amplifier and a period meter are applied to a modulator-amplifier and the output is used to control the regulating rods. A circuit of the transistorized modulator-amplifier is given. A non-linear feedback loop in the deviation amplifier reduces the rate of change of reactor power as the power approaches the final value. The power is maintained constant within 0.1% over long periods.
W.G.Stripp

2264 THE APPLICATION OF LIAPOUNOV'S SECOND METHOD TO THE STUDY OF AUTOMATIC REGULATING SYSTEMS FOR NUCLEAR REACTORS. M.Marinesco and V.M.Popov.
Nuclear Electronics Conference, Paris, 1958, Vol. II. (see Abstr. 12720 of 1960) p. 29-37. In French.
The study starts from the equations $dn/dt = (\rho/\tau)n$ and $u = A\,(n - n_0)$, where n is the neutron density, ρ the reactivity, τ the mean life of a thermal neutron, and u is the error signal. If z represents the position of the regulating rods, $\rho/\tau = \varphi(z)$. Putting $\nu = n - n_0$, one derives the equations $d\nu/dt = (z)\,(\nu + n_0)$ and $dz/dt = -f(A\nu)$, of which a trivial solution is $\nu = 0$, $z = 0$. This corresponds to equilibrium of the system, and its stability is studied by deriving Liapounov's function. It is shown that periodic solutions are possible. The damping effect of a signal proportional to the reactivity is next studied and it is shown that the trajectories in the phase plane then tend toward the origin, and that the damping effect is greater as f(u) is increased, that is the speed of the rods should be as high as possible. A further analysis shows that delayed neutrons have no detrimental effect on the stability.
W.G.Stripp

2265 CONTROL OF A NUCLEAR REACTOR IN THE SUB-CRITICAL REGION. J.Lacour and V.Raievski.
Onde elect. (France), Vol. 38, 592-9 (Aug.-Sept., 1958). In French.

2266 THE SLOWING-DOWN SPECTRUM IN A HETERO-GENEOUS REACTOR. C.B.Bigham and R.M.Pearce.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 457-8 (Nov., 1959).
Experiments were performed to measure the aeriation of the slowing-down neutron spectrom from E^{-1} in a heterogeneous arrangement of fuel rods and heavy water moderation. The measurements were done in a ZEEP lattice cell and confirmed that the aeriation becomes greater as the neutron energy and the lattice pitch increases. The results were compared with a 19 group calculation of the flux and the agreement is considered satisfactory.
J.F.Hill

2267 INVESTIGATIONS OF THE GENERALIZED ALBEDO PROBLEM. M.Richter.
Ann. Phys. (Germany), Vol. 6, No. 3-4, 221-6 (1960). In German.
Measurements were made of the generalized albedo of cadmium sheets with various thicknesses in a paraffin cylinder. To do this, a uniform thermal neutron field was required. It was produced by rotating the paraffin cylinder near a 500 mc Ra–Be source in two positions, thus giving the effect of a Volz neutron source. The results agree with Lyon's albedo theory [Ann. Phys. (Germany), Folge 6, Vol. 4, 379 (1949)] to within experimental accuracy.
D.H.Lord

2268 CRITICALITY OF MTR-TYPE FUEL ELEMENTS. R.E.Lightle.
Nucleonics (USA), Vol. 18, No. 7, 59 (July, 1960).
Nucleonics Data Sheet No. 38. A graphical method giving the K_{eff} of a nearly critical assembly of MTR elements in light water to an accuracy of 4%.
R.D.Smith

2269 PNEUMATIC GAUGES FOR IN-PILE MEASUREMENTS. J.Pefhany.
Nuclear Engng (GB), Vol. 6, 77-9 (Feb., 1961).

A description is given for the development of a pneumatic gauge for in-pile measurements of very small movements. Work done suggests that accurate results can be expected at temperatures in excess of 400°C.

ATOMIC AND MOLECULAR PHYSICS

2270 ON A RIGID SPHERE MODEL IN THE THEORY OF THE SHIFT AND BROADENING OF SPECTRAL LINES BY COLLISIONS. ATTRACTING RIGID SPHERES.
F.Schuller and B.Vodar.
C.R. Acad. Sci. (France), Vol. 251, No. 18, 1877-9 (Oct. 31, 1960). In French.

The problem is treated as a perturbation of the rigid-sphere potential by an attractive potential: if the latter is taken to be a London potential, the results are the same as those of the quasi-classical Weisskopf–Lindholm theory (1942) when the rigid-sphere model is introduced. J.Hawgood

ATOMS

2271 THE GENERALIZED METHODS OF HARTREE AND FOCK. Ya.I.Vizbaraite, K.K.Éringis and A.P.Yutsis.
Dokl. Akad. Nauk SSSR, Vol. 135, No. 4, 809-10 (Dec. 1, 1960). In Russian.

By the generalized Hartree and Fock methods, the authors mean the corresponding self-consistent field methods using different radial one-electron wave functions in the same shell. To simplify the calculations, the use of the generalized Hartree method for obtaining the radial one-electron wave-functions is suggested. All other calculations should be carried out by the generalized Fock method. The energy of the $2p^2$ shell in the Be atom ($1s^22p^2$ configuration) is calculated using the generalized methods and a marked improvement in the results as compared with the results obtained with ordinary methods is shown. [English translation in: Soviet Physics–Doklady (USA)]. F.Herbut

2272 PERTURBATION TREATMENT OF HARTREE–FOCK EQUATIONS. J.Linderberg.
Phys. Rev. (USA), Vol. 121, No. 3, 816-19 (Feb. 1, 1961).

For atomic configurations ($1s^2$), ($1s^22s$), and ($1s^22s^2$), perturbation theory is used to obtain (1/Z) expansions for the Hartree–Fock energies.

2273 ON THE CALCULATION OF THE POLARIZABILITIES OF ATOMS WITH INCOMPLETE SHELLS. L.C.Cusachs.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1724-6 (Oct. 24, 1960). In French.

Extension of the method of Pople and Schofield (Abstr. 8789 of 1957). J.Hawgood

2274 RELATIVISTIC K ELECTRON WAVE FUNCTIONS BY THE VARIATIONAL PRINCIPLE. W.N.Asaad.
Proc. Phys. Soc. (GB), Vol. 76, No. 5, 641-9 (Nov., 1960).

The variational principle is applied to obtain the Dirac wave-functions of the K-electrons of heavy atoms, using the method of variable parameters. In formulation, three parameters are used. The Coulomb and spin–spin interactions of the two K-electrons are taken into consideration as well as the effect of the rest of the atom. A numerical example for mercury, Z = 80 is given. Its K-absorption edge was calculated and relativistic wave-functions obtained, using one variable parameter. The results justify the use of screened hydrogenic wave-functions although the screening constant (~0.5) was somewhat higher than that given by Slater's rules. Calculations using two variable parameters are also given and the total energy is found to have a saddle point and not a true minimum. This is briefly discussed in the light of the hydrogen atom.

2275 ENERGY LEVELS FOR THE COULOMB POTENTIAL WITH CUT-OFF.
A.El Sadek El Meligy and M.A.El Sherbini.
Z. angew. Math. Phys. (Switzerland), Vol. 10, No. 5, 474-7 (Sept. 25, 1959).

Resuming Wannier's work (Abstr. 819 of 1944) a rigorous solution is given that is valid for low as well as high energy levels. This is achieved by using exact expansions for the wave-functions. The values of k in the equation $E = -\hbar^2\alpha^2/2mk^2$ are determined by equating, at $x = x_0$, the logarithmic derivatives with respect to x of the wave-functions of the electron in the potential field. For $x = 2.6$ the value of k for the 1s-state is 1.161 as compared with Wannier's 1.153. R.Schnurmann

2276 NEW VALUES OF THE SQUARE OF THE RADIAL INTEGRAL ASSOCIATED WITH THE DIPOLE MATRIX ELEMENTS FOR TRANSITIONS IN HYDROGEN-LIKE ATOMS.
R.Herdan and T.P.Hughes.
Astrophys. J. (USA), Vol. 133, No. 1, 294-8 (Jan., 1961).

The squares of the integrals $R_{n,l}^{n',l'}$ have been evaluated with the aid of an electronic computer for all transitions with $n, n' \leq 10$. Except for the transitions 4-7, the new values agree well with those given for a more limited range by Bethe and Salpeter.

2277 CONTINUOUS ABSORPTION DUE TO FREE–FREE TRANSITIONS IN HYDROGEN.
T.Ohmura and H.Ohmura.
Phys. Rev. (USA), Vol. 121, No. 2, 513-17 (Jan. 15, 1961).

The absorption of radiation in the free–free transition of the negative hydrogen ion is the inverse process of bremsstrahlung for an electron in the vicinity of a neutral hydrogen atom. This process is the most important cause of continuous absorption by the atmosphere of the sun and stars in the infrared region. The transition matrix element is expressed, with sufficient accuracy, in terms of the s phase shifts of electron–hydrogen atom scattering alone. To meet the requirement in astrophysical studies, the continuous absorption coefficients due to the free–free transition are tabulated for a wide range of wavelengths (4050 A to infinity) and temperatures (2520 to 10 080°K) of the hydrogen gas, by using s phase shifts of e–H scattering which include exchange and correlation effects between two electrons. The tabulated coefficients are 20-70% less than the ones computed by Chandrasekhar and Breen (1946), who used Hartree functions without exchange. Further improvement of the present result is discussed.

2278 HELIUM ATOM WAVE FUNCTIONS FROM SLATER ORBITALS OF NONINTEGRAL PRINCIPAL QUANTUM NUMBER. L.C.Snyder.
J. chem. Phys. (USA), Vol. 33, No. 6, 1711-12 (Dec., 1960).

Slater orbitals of nonintegral principal quantum number have been used to construct a He ground-state wave-function of the form

$$\Psi = c_1(ns, n's) + c_2(n''p)^2 + c_3(n'''d)^2 + c_4(n''''f)^2.$$

The variation method has been employed to determine the five orbital exponents, the five principal quantum numbers n, and the four linear coefficients. The minimized energy is 0.0058 a.u. above the nonrelativistic limit of −2.9027 a.u. computed by Pekeris. This may be compared with a difference of 0.0063 a.u. obtained by Taylor and Parr upon minimizing the energy of the same wave-function constrained to have integral principal quantum numbers.

2279 ELECTRONIC STRUCTURE OF ATOMIC SULPHUR. R.Gáspár.
Acta phys. Hungar., Vol. 12, No. 2, 171-7 (1960). In German.

The radial electronic wave-functions and electron density of the

nd p-electrons in the ground state of sulphur are calculated for iversal potential field. R.W.Nicholls

2280 MAGNETIC RESONANCE OF ATOMIC LEVELS OF HELIUM-4 EXCITED BY ELECTRON BOMBARDMENT.
ecomps, J.C.Pebay-Peyroula and J.Brossel.
Acad. Sci. (France), Vol. 251, No. 7, 941-3 (Aug. 17, 1960). In ich.
Magnetic resonance in states excited by electron bombardment tr. 20557-8 of 1960) is used to determine lifetimes and Landé ors for the levels 3^1D_2, 4^1D_2 and 5^1D_2 of helium-4, from obser- ons of transitions from these levels to the 2^1P_1 level. A similar tment is applied to two 3^3P levels, on the basis of assumptions ssitated by complications due to fine structures. Some features difficulties met in observations of other resonances are out- i. J.Sheridan

2281 WIDTH OF THE MAGNETIC RESONANCE OF THE 4^3P_1 LEVEL OF ZINC EXCITED BY ELECTRON MBARDMENT. A.D.May.
. Acad. Sci. (France), Vol. 251, No. 14, 1371-2 (Oct. 3, 1960). rench.
Reasons are discussed for the width previously found (Abstr. 30 of 1960) being greater than corresponds to the lifetime of the l found by H.Brück (Thesis, Paris, 1942). These are: too small thode-plate separation in the bombardment cell, causing the n lifetime between electrode collisions to be less than the life- e of the state; inhomogeneity in the applied field; parasitic netic fields from the cathode heater. Practical steps are cribed to eliminate these influences. Studies involving pressure ations established no change in limiting width due to zinc–zinc isions. New measurements with these improvements and rections yield a lifetime of 1.0×10^{-5} sec, still only one third ck's value. Stray 50 c/s fields and inhomogeneity of the radio- uency field could contribute line-broadenings which would unt for this difference. Lifetimes greater than 10^{-5} sec are rminable only with difficulty by this method. J.Sheridan

2282 ANGULAR DISTRIBUTION OF LYMAN-α RADIATION EMITTED BY H(2S) ATOMS IN WEAK ELECTRIC LDS. W.Lichten.
. Rev. Letters (USA), Vol. 6, No. 1, 12-13 (Jan. 1, 1961).
The author points out that the angular distribution of the radi- is isotropic, and discusses the circumstances under which one d expect this to be so. The values of the absolute cross-section xcitation of the 2S state of H by electron impact obtained by et al. (Abstr. 17689 of 1960) and by Schultz and Lichten (Abstr. of 1960) are compared with the theoretical values, correcting e necessary for Fite's assumptions about the isotropy. G.H.C.Freeman

2283 APPARATUS FOR SPECTRAL ANALYSIS AT HIGH RESOLUTION IN THE ULTRAVIOLET. APPLICATION 'HE MEASUREMENT OF HYPERFINE INTERVALS OF THE LEVEL OF Hg^{199} AND Hg^{201}. R.Lennuier and D.Lagarde.
Acad. Sci. (France), Vol. 251, No. 17, 1762-4 (Oct. 24, 1960). rench.
The apparatus is described and results obtained on the hyper- structure of the 2537 A Hg line are presented. G.I.W.Llewelyn

2284 PRECISE MEASUREMENT OF THE HYPERFINE STRUCTURE OF 6 $^2P_{3/2}$ TERM OF Rb I SPECTRUM.
cka, H.Kopfermann and A.Minor.
ys. (Germany), Vol. 161, No. 2, 123-31 (1961). In German.
The h.f.s. transitions in the excited 6 $^2P_{3/2}$ state were measured e double resonance method using isotopic enriched samples of and Rb^{87}. The A-factors and B-factors were evaluated the measured frequencies: $A_{85} = 8.178 \pm 0.009$ Mc/s, 8.199 ± 0.04 Mc/s, $A_{87} = 27.707 \pm 0.015$ Mc/s and $B_{87} =$ ±0.039 Mc/s.

2285 INTERFERENCE EFFECTS IN THE RESONANCE FLUORESCENCE OF "CROSSED" EXCITED ATOMIC 'ES. P.A.Franken.
. Rev. (USA), Vol. 121, No. 2, 508-12 (Jan. 15, 1961).
The spectroscopic method developed by Colegrove, Franken, s, and Sands (Abstr. 2732 of 1960) exploits interference effects occur in the resonance fluorescence of atoms exhibiting of "crossed" excited states. Some of the theoretical features of the technique are discussed in terms of the formalism developed by Breit from which the salient features of the observed lineshapes can be readily deduced. Alternative derivations of the Breit formula are given together with a discussion of the nature and representation of the requisite resonance radiation.

2286 STARK BROADENING OF SPECTRAL LINES BY HIGH-VELOCITY CHARGED PARTICLES. M.Lewis.
Phys. Rev. (USA), Vol. 121, No. 2, 501-5 (Jan. 15, 1961).
The broadening of the Lyman-α line by high-velocity charged particles is calculated in the classical path approximation without the completed-collision assumption. For noninteracting perturbers, the divergence at large impact parameters associated with usual impact theories does not arise. Interactions between the perturbers are introduced by the pair correlation function. The resulting line shape is valid for frequencies larger than those permitted by the impact theory.

2287 OSCILLATOR STRENGTH FOR THE $3s3p^2\ ^2S–3s^2\ 3p^2P$ TRANSITION IN AL I.
J.A.Eddy, L.L.House and H.Zirin.
Astrophys. J. (USA), Vol. 133, No. 1, 299-302 (Jan., 1961).
The oscillator strength for the transition $1s^22s^22p^63s^23p^2\ ^3P_{3\ 2,1\ 2}–1s^22s^22p^63s3p^2\ ^2S_{1\ 2}$ of Al I has been calculated. A potential was obtained which allowed a numerical solution of the Schrödinger equation for the ground- and excited-state wave functions. An f-value of 0.34 was computed from both the dipole and the momentum matrix elements, using theoretical energy levels. This is thought to be a more reliable value than that derived from observed energies.

2288 THE HYPERFINE STRUCTURE OF ^{209}Bi.
R.S.Title and K.F.Smith.
Phil. Mag. (GB) (Eighth Ser.), Vol. 5, 1281-9 (Dec., 1960).
The hyperfine structure (h.f.s.) of the J = 3/2 ground state of Bi^{209} was found by the atomic-beam magnetic resonance method. Two of the three h.f.s. intervals were measured directly, giving $(W_{50} - W_{60})/h = 2884 \pm 0.2$ Mc/s and $(W_{40} - W_{50})/h = 2171.5 \pm 0.1$ Mc/s. These results were consistent with a magnetic dipole interaction constant A of -446.97 ± 0.04 Mc/s and an electric quadruple interaction constant B of -303.3 ± 0.3 Mc/s. The latter yields an uncorrected nuclear electric quadrupole moment of −0.34 barns, and the field dependence of $\Delta F = 0$ transitions gives -1.6433 ± 0.0002 for the ground state g_j value. The results are discussed in terms of the intermediate coupling theory of Breit and Wills (1933).

2289 DETERMINATION OF ATOMIC CONCENTRATIONS IN ARC PLASMA BY A PULSE ABSORPTION METHOD.
L.D.Kondrasheva and I.V.Podmoshenskii.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 281-7 (Sept., 1960).
In Russian.
Describes a pulse method for recording absorption spectra of arc plasmas at temperatures up to 6000°K. In a Fe–Cu d.c. arc the volume occupied by excited atoms (energy levels of about 3 eV) amounted to about 30% of the volume occupied by non-excited atoms. Instantaneous concentrations of Fe, Cr and Mn atoms were determined. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 149-51 (Sept., 1960)]. A.Tybulewicz

2290 STARK BROADENING OF HIGHER HYDROGEN AND HYDROGEN-LIKE LINES BY ELECTRONS AND IONS.
H.R.Griem.
Atrophys. J. (USA), Vol. 132, No. 3, 883-93 (Nov., 1960).
A recently developed theory for the impact broadening of overlapping lines is applied to describe the influence of electrons on the line profiles. The broadening by ions is treated by using the quasi-static theory. Approximate expressions are derived for the profile of any hydrogen-like line broadened by both electrons and ions.

2291 ABSORPTION OF KRYPTON IN THE EXTREME ULTRAVIOLET. A.Pery-Thorne and W.R.S.Garton.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 833-43 (Dec. 1, 1960).
The far ultraviolet absorption spectra of the heavier inert gases are characterized by strong, diffuse lines in the region between the $^2P_{3/2}$ and $^2P_{1/2}$ series limits. These lines have large natural widths, owing to the high probability of auto-ionization of their upper levels. Their oscillator strengths were measured to calibrate the photographic plates. The f-values found, 0.04 for the strongest line and 0.10 for the sum of all the lines, were much smaller than had been expec-

ted on the basis of dispersion measurements. Rough measurements of the continuous absorption in krypton from the $^2P_{1/2}$ series limit to 500 A were made directly with a photomultiplier, and it is shown that absorption in this continuum, the diffuse lines and the resonance lines probably accounts for only about two-thirds of the refractive index measured in the quartz ultraviolet region.

2292 ISOTOPE SHIFTS IN THE SPECTRA OF Mo AND Ru. R.H.Hughes.
Phys. Rev. (USA), Vol. 121, No. 2, 499-500 (Jan. 15, 1961).

Isotope shifts in several lines showing shifts in the field-effect direction were studied with the aid of a Fabry–Perot interferometer. The variations in the shifts are quite similar in the two elements. A distinct minimum shift between the even–even nuclei occurs at neutron number 56. Extreme even–odd staggering inverts the expected order of the atomic levels belonging to nuclei with neutron numbers 54 and 55. The variations in the shifts were qualitatively predicted by the nuclear deformations as measured by Coulomb excitation, particularily in the case of molybdenum.

2293 STRUCTURE AND ZEEMAN EFFECT IN THE SPECTRA OF THE OSMIUM ATOM, Os I AND Os II. IV-VI.
A.M.van Kleef.
Proc. K. Ned. Akad. Wetensch. B (Netherlands), Vol. 63, No. 5, 549-64, 565-80, 581-601 (1960).

For Pt I-III, see Abstr. 20588 of 1960. Tables are given of the classified lines of Os I and II, together with other pertinent data.

RATE OF THE THREE-BODY ATOMIC OXYGEN REACTION FOR THE EXCITATION OF THE AIRGLOW O I (5577 A) LINE.
See Abstr. 1552

2294 THE HYPERFINE STRUCTURE OF ^{121}Sb AND ^{123}Sb. P.C.B.Fernando, G.K.Rochester, I.J.Spalding and K.F.Smith.
Phil. Mag. (GB),(Eighth Ser.), Vol. 5, 1291-8 (Dec., 1960).

The hyperfine structure of the J = 3/2 ground state of Sb^{121} and Sb^{123} was studied by the atomic-beam magnetic-resonance method, and the results were consistent with the following values for the interaction constants: $g_J = -1.970\,5 \pm 0.000\,2$, $A_{121} = -(299.034 \pm \pm 0.004)$ Mc/s, $A_{123} = -(162.451 \pm 0.003)$ Mc/s, $B_{121} = -(3.68 \pm \pm 0.02)$ Mc/s, and $B_{123} = -(4.67 \pm 0.03)$ Mc/s. To the accuracy of the measurements there was no evidence for an octupole interaction. From the B values one obtains $Q_{121} = -(0.20 \pm 0.03) \times 10^{-24}$ cm^2 and $Q_{123} = -(0.26 \pm 0.04) \times 10^{-24}$ cm^2, and comparison of A_{121}/A_{123} with the ratio of g_{121}/g_{123} already published gives -0.318 ± 0.003% for the hyperfine structure anomaly. Intermediate coupling theory accounts satisfactorily for g_J, but an admixture of excited s-states is necessary to explain the observed magnetic interaction and anomaly.

2295 HYPERFINE STRUCTURE AND ISOTOPIC SHIFT IN THE Tl I SPECTRUM. A.I.Odintsov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 142-6 (Aug., 1960). In Russian.

Hyperfine splittings and isotopic shifts of the $6^2P_{3/2}$, $8^2P_{1/2}$, $8^2P_{3/2}$, $9^2P_{1/2}$, $9^2P_{3/2}$, $10^2P_{3/2}$, $7^2S_{1/2}$ levels of the 5110, 5350, 5528, 5584, 6550, and 6714 A lines were determined using an atomic beam and a Fabry–Perot etalon. More accurate values of isotopic shifts were obtained. Hyperfine structure data were used to make some deductions about configuration interactions in thallium atoms. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 75-7 (Aug., 1960)]. A.Tybulewicz

2296 NEW RELATIONSHIPS IN THE X-RAY K AND L SATELLITES. G.B.Deodhar and S.T.H.Abidi.
Naturwissenschaften (Germany), Vol. 47, No. 14, 319 (1960).

Some relationships between low-frequency non-diagram lines and the principal lines in the X-ray emission spectra of elements are discussed. G.I.W.Llewelyn

2297 THE NUMERICAL SOLUTION OF THE EXCHANGE EQUATIONS FOR SLOW ELECTRON COLLISIONS WITH HYDROGEN ATOMS. T.L.John.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 532-8 (Oct., 1960).

Numerical methods are used to calculate phases in the exchange approximation for the s-, p- and d-wave scattering of electrons by hydrogen atoms, using small energy intervals. There is a discussion of experimental results.

2298 APPLICATION OF THE METHOD OF POLARIZED ORBITALS TO THE SCATTERING OF ELECTRONS FROM HYDROGEN. A.Temkin and J.C.Lamkin.
Phys. Rev. (USA), Vol. 121, No. 3, 788-94 (Feb. 1, 1961).

For previous work, see Abstr. 5437 of 1958; 1476 of 1960. The s-, p-, and d-wave scattering of slow electrons from atomic hydrogen is calculated by the method of polarized orbitals. Utilization of a transformation of Omidvar avoids the iterative procedure of solving the associated integro-differential equations. The s-wave scattering is smaller than that given by the exchange approximation, and the scattering lengths are within the upper bo found by Rosenberg, Spruch, and O'Malley. The d-wave phase sh are too small to explain a resonance in the total cross-section. However, they are much larger than those of the exchange or Bor approximation, and they give considerable structure to the differential cross-section curves. The p-wave phase shifts are not mu increased by the polarization effects. Comparison is made with experimental results of the following abstract.

2299 COLLISIONS OF ELECTRONS WITH HYDROGEN AT VI. ANGULAR DISTRIBUTION IN ELASTIC SCATTE H.B.Gilbody, R.F.Stebbings and W.L.Fite.
Phys. Rev. (USA), Vol. 121, No. 3, 794-98 (Feb. 1, 1961).

For Pt V, see Abstr. 17689 of 1960. The angular distribution of electrons scattered elastically by hydrogen atoms was determine for electron energies below 10 eV. The elastically scattered electrons arising from the interaction of crossed electron and modulated hydrogen-atom beams were examined over an angular range extending from 30° to 120°. The results are discussed with reference to other recent experimental and theoretical developm

2300 DRIFT VELOCITIES OF SLOW ELECTRONS IN HELIUM, NEON, ARGON, HYDROGEN, AND NITRO J.L.Pack and A.V.Phelps.
Phys. Rev. (USA), Vol. 121, No. 3, 798-806 (Feb. 1, 1961).

The drift velocities were measured for E/p values between and 10 V/cm-mm Hg at temperatures between 77° and 373° K. T data were obtained from measurements of electron transit time an improved version of the double-shutter tube developed by Bradbury and Nielsen (1936). By applying sufficiently small vo pulses to the control grids, it was possible to eliminate end effe present in previous experiments. Values of the momentum tran cross-sections for electrons with energies between about 0.003 0.05 eV are obtained which are consistent with the measured dr velocities for thermal electrons in helium, argon, hydrogen, an nitrogen. The derived momentum transfer cross-section for ele trons in helium is found to be independent of electron energy and equal to 5.3×10^{-16} cm^2. The momentum transfer cross-section for argon, hydrogen, and nitrogen vary with electron energy.

2301 DEPENDENCE OF THE INELASTIC COLLISION CROSS-SECTIONS OF ATOMS AND IONS ON VELOC IN THE CASE OF PSEUDO-INTERSECTION OF THE LEVELS. Yu. P.Mordvinov and O.B.Firsov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 427-31 (Aug., 19 In Russian.

The dependence is examined in the case of pseudo-intersect of the levels of the system of colliding particles. The time dependence of the electron wave-functions is taken into account terms of the radius vectors of the nuclei. The perturbation mat element in the Landau–Zener formula includes the usual station separation of the levels as well as a term which takes into accou the indicated dependence of the electron wave-functions on time Under certain conditions, the dependences of the cross-sections velocity may be curves with two peaks. [English translation in: Soviet Physics–JETP (USA), Vol. 12, No. 2, 301-3 (Feb., 1961)].

RANGES AND RANGE STRAGGLING OF Tb^{149}, At, AND Po ATOMS IN Al AND Au. See Abstr. 2244

2302 THE RELATIVISTIC THEORY OF K IONIZATION B ELECTRONS. H.S.Perlman.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 623-40 (Nov., 1960).

Relativistic cross-sections for the K-shell ionization of ligh to heavy atoms by fast electrons were deduced using the Møller interaction. The effect of electron exchange and the validity of th Born approximation are discussed. Suitable kinds of wave-fun for the K-electron are considered. Ionization cross-sections w

lated for mercury using Dirac wave-functions and for nickel Darwin wave-functions. The cross-sections for nickel agree with experiment. Those for mercury await experimental con-tion.

topes

2303 THE ELECTROMAGNETIC ISOTOPE SEPARATOR IN PRETORIA. W.E.Frahn, W.L.Rautenbach and L.Wahlin.
ear Instrum. and Methods (Internat.), Vol. 7, No. 3, 253-68 , 1960).
A technical description is given of the electromagnetic isotope rator in Pretoria. This machine is a laboratory separator of Scandinavian" type using a 90° magnetic sector field of mean s 180 cm, a maximum acceleration voltage of 80 kV, an electro- lens system with two-directional focusing, and magnetic arc es with end extraction. Special design features make the ument suitable for the performance of certain nuclear experi- s. Particular attention has been given to ion beam formation separator in order to obtain optimum resolving power and transmission at high ion currents.

2304 IMPROVEMENTS OF THE COLLECTOR SYSTEM FOR A LABORATORY ISOTOPE SEPARATOR. L.Wahlin.
ear Instrum. and Methods (Internat.), Vol. 7, No. 3, 269-73 , 1960).
An improved beam position stabilizer, a new line scanning e and an automatic recording system are described. This ment is used in the electromagnetic isotope separator in the ear Physics Division of the National Physical Research Labora- in Pretoria.

2305 A SPECTROSCOPIC DETERMINATION OF THE ISOTOPIC COMPOSITION OF CARBON.
Zaidel' and G.V.Ostrovskaya.
ta i Spektrosk. (USSR), Vol. 9, No. 2, 137-41 (Aug., 1960).
ussian.
Describes a spectroscopic method analogous to that employed er for hydrogen [Ibid., Vol. 1, 972 (1956)]. The carbon spectra excited in an electrodeless high-frequency discharge and were ded with a diffraction monochromator and a photomultiplier. isotopic composition was deduced from the ratio of intensities e $C^{13}O$ and $C^{12}O$ bands at 4131.8 and 4123.6 A respectively. At C^{13} concentrations (1-5%) the scatter of results was represented coefficient of variation of 5-7%. At C^{13} contents amounting to % a coefficient of variation was 2-3%. [English translation in: s and Spectrosc. USA , Vol. 9, No. 2, 78-80 (Aug., 1960)].
A.Tybulewicz

2306 SEPARATION FACTOR OF TRITIATED WATER IN FRACTIONAL DISTILLATION. P.Avinur and A.Nir.
e (GB), Vol. 188, 652 (Nov. 19, 1960).
The authors reconsider their previous work [Liquid Scintillation ing. London: Pergamon Press (1958) p. 283] and give some ates of their errors in the light of results published by Price r. 3935 of 1958).
M.Ebert

MOLECULES

07 SEARCH FOR A SMALL CHARGE CARRIED BY MOLECULES. J.G.King.
Rev. Letters (USA), Vol. 5, No. 12, 562-5 (Dec. 15, 1960).
careful attempt was made to measure the charge believed arried by hydrogen molecules and helium atoms, by observing rent flowing to an isolated gas container, on an electrometer, as was allowed to escape at a measured rate from the con- Comparison of the experimental "container potential/time" th a theoretical curve deduced on the assumption that the s uniformly charged indicated that a possibly large spurious vas operating. If allowance was made for this effect, the per hydrogen molecule was computed to be $(7 \pm 2.5) \times 10^{-20}$ tary charges and the charge per helium atom $(0 \pm 2) \times 10^{-20}$ tary charges.
G.Carter

2308 PROTON MOTIONS IN AMMONIUM HALIDES BY SLOW NEUTRON CROSS-SECTION MEASUREMENTS.
J.J.Rush, T.I.Taylor and W.W.Havens, Jr.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 507-9 (Dec. 1, 1960).
The proton motions in ammonia have been studied using a crystal spectrometer at the Brookhaven Reactor. The data for the four ammonium halides reported here show that total cross-section measurements can give valuable evidence concerning the dynamics and chemical bonding of hydrogen in molecules and crystals. Measurements are being extended to other ammonium salts and hydrogen compounds.
T.E Peacock

2309 EXCITATION AND NEGATIVE IONS IN H_2O.
G.J.Schulz.
J. chem. Phys. (USA), Vol. 33, No. 6, 1661-5 (Dec., 1960).
By combining the trapped-electron method with the study of negative ions and positive ions, it is possible to obtain data which can be used for construction of an approximate potential energy diagram of molecules. The experimental methods used are described and the H_2O molecule is discussed. The negative ion current peaks at 6.5 ± 0.1 and 8.8 ± 0.1 eV. Kinetic energy measurements on the negative ions show that the latter peak is associated with the same state at infinite separation as the first peak. The inelastic loss processes are essentially in agreement with optical absorption experiments. An inelastic process with a threshold at about 3.4 eV is observed.

2310 SHOCK EXCITATION OF SOLID AROMATIC HYDROCARBONS. R.W.Nicholls and M.D.Watson.
Nature (GB), Vol. 188, 568-9 (Nov. 12, 1960).
Emission spectra of the luminosity arising from the shock excitation of powdered solid naphthalene and anthracene and (frozen) solid benzene were studied and found to consist of bands of the CN violet, C_2 Swan, and CH systems together with a carbon-particle continuum. The continued appearance of the molecular features, even at the highest temperatures of the reflected shock wave, is in sharp contrast to similar studies on shock-excitation of solid inorganic oxides (Abstr. 5158 of 1957) in which molecular features appear at lower temperatures and atomic features appear at the higher temperatures.
R.W.Nicholls

2311 OPTICAL EXCITATION OF N_2 BY 0.5 TO 1.5 MeV HYDROGENIC IONS.
E.M.Reeves, R.W.Nicholls and D.A.Bromley.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 217-22 (Aug., 1960).
The luminosities produced by 0.5 to 1.5 MeV beams of H^+, HH^+, HHH^+ were studied spectroscopically in N_2 at pressures below 100 μ Hg. Photography and identification of spectra, measurement of the variation of intensities of spectral features with pressure, and spectroscopic temperature measurements confirm a primary mechanism of single-collision ionization with excitation. Effects of secondary excitation processes by secondary electrons produced in the primary processes are discussed.

2312 FORCES IN MOLECULES. I. APPLICATION OF THE VIRIAL THEOREM. W.L.Clinton.
J. chem. Phys. (USA), Vol. 33, No. 6, 1603-6 (Dec., 1960).
It is shown that the virial theorem can be used to derive a force constant expression that sheds new light on the process of molecular binding. In connection with the latter the quantum-mechanical virial theorem is derived in such a way as to be useful in discussing molecular applications in which the Born–Oppenheimer approximation is applied.

2313 TRANSFERABILITY OF UREY–BRADLEY FORCE CONSTANTS. V. BROMOETHYLENES.
J.R.Scherer and J.Overend.
J. Chem. Phys. (USA), Vol 33, No. 6, 1681-94 (Dec., 1960).
Urey–Bradley force constants (UBFC's), calculated by a least-squares method, were obtained for ethylene, vinyl bromide, vinylidene bromide, trans-dibromoethylene, cis-dibromoethylene, tribromoethylene, and tetra bromoethylene. Even with complete isotopic data it was found impossible to determine all the force constants for an individual bromoethylene; moreover, from the viewpoint of giving stability to the calculation, values have been supplied by transfer from other molecules within this series and these force constants have been constrained in the least-squares refinement. By inspection of the correlation matrix, the uncertainties in the various force constants were, in many cases, found

to be intimately related, and, it was usually found unnecessary to constrain both force constants of an indeterminate pair; in this manner the number of transferred force constants was kept to a minimum. A comparison of the remaining UBFC's shows that they are moderately transferable. Although the flexible bond parameter S_{HH} was found to be significant (but not transferable) in those molecules containing hydrogen atoms trans to one another, i.e., ethylene, vinyl bromide, and trans-dibromoethylene, its value in cis-dibromoethylene, its value in cis-dibromoethylene was small and made no significant contribution in explaining the observed frequencies. A potential function which includes a quadratic cross term between trans-hydrogen bending coordinates was found to be adequate throughout the series and moderately transferable.

2314 ROTATIONAL TRANSITIONS IN HYDROGEN AND DEUTERIUM. K.Takayanagi.
J. Phys. Soc. Japan, Vol. 14, No. 1458-9 (Oct., 1959).

Gives results of calculations of transition probabilities similar to those of Abstr. 6393 of 1957 but including transitions up to the fourth rotational level. The ultrasonic dispersion curves for hydrogen and deuterium are calculated for 200°K and 300°K, and agree reasonably well with experiment except for the lower end of the frequency scale at 300°K. J.Hawgood

2315 ROTATIONAL ANALYSIS OF THE 5–1 BAND OF THE B'–B SYSTEM OF N_2. P.K.Carroll and H.E.Rubalcava.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 337-45 (Sept., 1960).

The 5–1 band of the recently discovered B' → B system of N_2 was photographed under large dispersion and a rotational analysis was made. The upper state was shown to be of species $^3\Sigma_u^-$ and the lower state was confirmed to be $B^3\Pi_g$. The rotational constants derived from the analysis were $B' = 1.381_6\,cm^{-1}$, $D' = 4.6 \times 10^{-6}\,cm^{-1}$, $B'' = 1.610_4\,cm^{-1}$, $D'' = 5.4 \times 10^{-6}\,cm^{-1}$. The spin structure of the $^3\Sigma_u^-$ state was determined and a discrepancy between theory and experiment noted.

2316 FREQUENCY SHIFT IN AMMONIA ABSORPTION LINES OTHER THAN (3,3). K.Matsuura.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1826 (Dec., 1959).

The shift coefficient, α, is defined by expressing the shift of the apparent centre of resonance to the high frequency side of the true line-centre as $\alpha/2$ times the line-width due to pressure broadening. For ammonia inversion lines with K equal to J, α varies approximately linearly with J. At 30°C its values run from 2.8×10^{-2} at J = 1, to zero at J = 6; at 100°C its values are uniformly some 0.7×10^{-2} lower, and become negative for J greater than 4. For the J=K=3 line, α decreases linearly as the temperature is increased from 20° to 150°C. The variable sign of α is taken to require at least two competing mechanisms for the shift. The low values of α for cases where J=K=5 or 6 recommend in particular the use of the strong, 6,6 line as an atomic clock standard. J.Sheridan

2317 ON THE ABSORPTION SPECTRUM OF CF_2 AND ITS VIBRATIONAL ANALYSIS. D.E.Mann and B.A.Thrush.
J. chem. Phys. (USA), Vol. 33, No. 6, 1732-4 (Dec., 1960).

The flash photolysis of CF_2Br_2 was used to obtain the absorption spectrum of the CF_2 radical. The principal features of the spectrum are a progression of the upper state bending frequency, and a number of weak bands which are shown to arise from a vibrationally excited lower state. There is no evidence for transitions involving stretching vibrations. The vibrationless origin of the system ($v_1' = 0$, $v_2' = 0$, $v_1'' = 0$, $v_2'' = 0$) is shown to lie at approximately 37 695 cm^{-1}. The deformation frequencies of the lower and upper states are about 660 and 500 cm^{-1}, respectively.

2318 A THEORY OF THE VIBRATIONAL SPECTRA OF POLYMERS. I. Yu.Ya.Gotlib.
Optika i Spektrosk. (USSR), Vol. 7, No. 3, 294-300 (Sept., 1959). In Russian.
[English translation in: Optics and Spectrosc.(USA)].

2319 A THEORY OF THE VIBRATIONAL SPECTRA OF POLYMERS. II. TWISTING SKELETAL VIBRATIONS IN SYNDIOTACTIC POLYMER CHAINS. Yu.Ya.Gotlib.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 319-25 (Sept., 1960). In Russian.

Derives equations of motion for skeletal twisting vibrations of plane syndiotactic chains in the case when the mass centre of the side group does not coincide with the skeletal carbon atom. Frequencies of two infrared-active skeletal twisting vibrations are calculated. Vibration forms are deduced and expressions are obtained for intensities in the zero approximation of the valence-optical method. The theory is used to discuss the experimental results relating to polyvinyl chloride, polyvinylidene chloride and polyacrylonitrile and their force constants are calculated. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 166-9 (Sept., 1960)]. A.Tybulewicz

2320 A ROUGH ESTIMATE OF THE FREQUENCIES OF NORMAL VIBRATIONS OF HAFNIUM HALIDES.
A.M.Aleksandrovskaya and I.N.Godnev.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 273-5 (Aug., 1960).
In Russian.

Normal vibration frequencies of gaseous $HfCl_4$, $HfBr_4$ and HfI_4, calculated using a procedure described earlier (1959), agreed satisfactorily with Hildebrand's curves (Abstr. 377 of 1948). The results were used to calculate the entropy of $HfCl_4$ treated as an ideal gas. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 144 (Aug., 1960)]. A.Tybulewicz

2321 PARTIAL FREQUENCIES OF PYRAMIDAL HYDRIDES AND DEUTERIDES OF C_{3v} SYMMETRY.
G.I.Rybakova, B.I.Naugol'nikov and V.P.Morozov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 166-9 (Aug., 1960).
In Russian.

The partial-frequency method [ibid., Vol. 7, 289 (1959)] was used in studies of vibrations of non-planar pyramidal molecules of RX_3 type, where X is H or D, and R is N, P, As or Sb. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 88-9 (Aug., 1960)]. A.Tybulewicz

2322 TRIMETHYLENE OXIDE. I. MICROWAVE SPECTRUM, DIPOLE MOMENT, AND DOUBLE MINIMUM VIBRATION. S.I.Chan, J.Zinn, J.Fernandez and W.D.Gwinn.
J. chem. Phys. (USA), Vol. 33, No. 6, 1643-55 (Dec., 1960).

The microwave spectra of four isotopic species of trimethylene oxide were investigated. Analysis of the spectra indicates that the four-membered ring is essentially planar. From the intensity measurements of the rotational transitions and their vibrational satellites, it is concluded that the energy levels in the ring-puckering vibration are single levels. The Stark effect also provided independent evidence that the ring is not highly puckered. The dipole moment of the molecule was found to lie solely on the C–O molecular axis. A value of 1.93 ± 0.01 debye was obtained. The existence of a small barrier in the potential function, however, was established by a detailed analysis of the observed vibration-rotation interaction. Quantitative considerations have led to an accurate determination of the barrier height and the general shape of the potential function. The barrier restricting the ring-puckering motion is found to be 35 ± 5 cm^{-1}. The ground vibrational level is 8 ± 4 cm^{-1} above the top of the barrier.

2323 VERY-HIGH-FREQUENCY ABSORPTION OF CH_3GeF_3. N.A.Irisova and E.M.Dianov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 261 (Aug., 1960).
In Russian.

Absorption lines of CH_3GeF_3 were recorded at 10-30 kMc/s. Variation of the relative intensities of these lines with temperature showed the presence of lines of both the ground and excited internal vibration states. The rotational constant B was found to be 3257 ± 1 Mc/s and the dipole moment of the molecule was 3.8 ± 2 debye. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 136 (Aug., 1960)]. A.Tybulewicz

2324 CALCULATION OF THE INTENSITIES AND POLARIZATIONS OF THE VIBRATIONAL ABSORPTION SPECTRA OF MULTIATOMIC MOLECULES. II. L.A.Gribov.
Optika i Spekstrosk. (USSR), Vol. 9, No. 2, 176-83 (Aug., 1960).
In Russian.

For Pt I see Abstr. 15721 of 1960. See also Abstr. 1531 of 1960. The intensities and polarizations of the vibrational spectra of multiatomic molecules were calculated using the vector representation of dipole moment variations. The method is illustrated on molecules of ethylene and ammonia. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 93-9 (Aug., 1960)].
A.Tybulewicz

325 INFRARED SPECTRA OF COMPLEXES OF NO_2F WITH BF_3, PF_5 AND SbF_5.
ok, S.J.Kuhn and G.A.Olah.
em. Phys. (USA), Vol. 33, No. 6, 1669-71 (Dec., 1960).
In each case bands at about 2360 cm^{-1} were recorded and are buted to the nitronium ion NO_2^+. Bands consistent with a plex anion of the form MF_{n+1}^- were observed, though with less racy. It is considered correct to designate these complexes as BF_4^-, $NO_2^+PF_6^-$, and $NO_2^+SbF_6^-$.

326 VIBRATIONAL SPECTRUM OF CRYSTALLINE ARSENIC OXIDE AND STRUCTURE OF ITS MOLE-ES. N.N.Sobolev and V.P.Cheremisinov.
ka i Spektrosk. (USSR), Vol. 9, No. 4, 446-51 (Oct., 1960). In sian.
Raman spectra (13 lines, two of which were strong) and infrared rption spectra (7 bands between 2.5 and 36 μ, six of which were ng) of arsenic oxide crystals were recorded. Analysis of these tra showed that the molecule of arsenic oxide is represented by $_{10}$ and belongs to the T_d point-group symmetry. The vibrational trum was interpreted. [English translation in: Optics and trosc. (USA)]. Vol. 9, No. 4, 233-5 (Oct., 1960). A.Tybulewicz

327 VIBRATIONAL SPECTRA OF SILICATES. I. INFRARED SPECTRA OF SILICATES WITH ANIONS HE $[Si_2O_7]^{6-}$ TYPE. A.N.Lazarev.
ka i Spektrosk. (USSR), Vol. 9, No. 2, 195-202 (Aug., 1960). ssian.
Reports studies of the infrared absorption spectra of several ates containing complex anions of the $[Si_2O_7]^{6-}$ type. Discusses rnal" vibrations of such ions and deduces spectroscopic criteria dentification and structure determination of these anions. lish translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 6 (Aug., 1960)]. A.Tybulewicz

328 ISOTOPE EFFECT IN BAND SPECTRA OF MAGNESIUM OXIDE. D.S.Pešić.
. Phys. Soc. (GB), Vol. 76, Pt 6, 844-8 (Dec. 1, 1960).
Some studies of the electronic spectrum given by magnesium in m arc in O^{18} and in a mixture of O^{16} and O^{18} were made. Measments of the isotope shift are given for the green and the ultra-t systems. The isotope effect in the green system confirmed ibrational analysis of Mahanti and Lagerqvist. The bands in traviolet region were again attributed to a polyatomic mole-containing magnesium and oxygen atoms. The assignment was y supported by the isotope shift, but the molecule contains a single oxygen atom.

329 ROTATIONAL ANALYSIS OF BORON MONOXIDE BANDS LYING IN THE VACUUM ULTRAVIOLET ON. Yu.Ya.Kuzyakov, V.M.Tatevskii and L.N.Tunitskii.
a i Spektrosk. (USSR), Vol. 9, No. 2, 156-61 (Aug., 1960). ssian.
The (1, 0) and (2, 0) bands of the $^2\Pi \rightarrow {}^2\Sigma$ transition in BO were sed and the following rotational constants were found for the $^2\Pi$: $B_0 = 1.4759$ and $\alpha = 0.0170$. [English translation in: Optics pectrosc. (USA), Vol. 9, No. 2, 84-6 (Aug., 1960)]. A.Tybulewicz

330 BAND SPECTRUM OF ALUMINIUM OXIDE. M.Becart and F.Declerck.
Acad. Sci. (France), Vol. 251, No. 20, 2153-4 (Nov. 14, 1960). nch.
he u.v. spectrum of the AlO molecule in the region -37 000 cm^{-1} is recorded and compared with previous data. new bands are recorded. G.I.W.Llewelyn

331 ULTRAVIOLET AND STRUCTURAL STUDIES OF POLYTHIONATES. R.M.Golding.
m. Phys. (USA), Vol. 33, No. 6, 1666-8 (Dec., 1960).
he ultraviolet spectral results of the polythionates are sed in light of various available theoretical approaches in tting inorganic complex spectral intensities and band ons. A semiempirical approach shows that the oscillator ths of the polythionate electronic spectra are related to the itals of the sulphur chain.

2332 DOUBLET SPLITTING IN THE $^2\Sigma-{}^2\Pi$ BAND OF C—H AT 3900 A. J.F.James.
Z. Phys. (Germany), Vol. 160, No. 4, 374 (1960). In German.
Measurements of the spin-doublet splittings of the lines of the (0, 0) band agree with those of Gerö [Z. Phys. (Germany), Vol. 118, 27 (1941)]. G.F.Lothian

2333 POTENTIAL ENERGY CURVES FOR CO. I.Tobias, R.J.Fallon and J.T.Vanderslice.
J. chem. Phys. (USA), Vol. 33, No. 6, 1638-40 (Dec., 1960).
Potential energy curves for the $X\ {}^1\Sigma^+$, $a\ {}^3\Pi_r$, $a'\ {}^3\Sigma^+$, $d\ {}^3\Delta$, $e\ {}^3\Sigma^-$, $A\ {}^1\Pi$, and $B\ {}^1\Sigma^+$ electronic states of the CO molecule have been calculated by the Rydberg—Klein—Rees method. The curve for the $A\ {}^1\Pi$ state will have to bend sharply in the range between 1.9 and 2.1 A or it will have to pass through a maximum to reach the proper dissociation limit.

2334 THE OSCILLATOR STRENGTH OF THE δ-BANDS OF NO. S.P.Erkovich and Yu.P.Pisarevskii.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 269-70 (Aug., 1960). In Russian.
The experimental data of Marmo (Abstr. 3311 of 1954) and Mayence (Abstr. 740 of 1953) yielded f = 0.0026 and f = 0.0032 respectively for the δ-band system of NO. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 141-2 (Aug., 1960)]. A.Tybulewicz

2335 TRANSITION PROBABILITIES FOR LOW-LYING ELECTRONIC STATES IN C_2. E.Clementi.
Astrophys. J. (USA), Vol. 132, No. 3, 898-904 (Nov., 1960).
The probabilities for nine electronic transitions among the low-lying excited states in the C_2 molecule are calculated by the dipole-moment operator method and are given in the form of oscillator strength (or f-values). The amount of hybridization in the $2\sigma_u$ and $3\sigma_u$ molecular orbitals are calculated with a semiempirical method closely related to the Mulliken "magic formula." The agreement between the coefficient of hybridization thus obtained with more refined calculations is satisfactory for the $^1\Sigma_g^+(a)$ ground state (the only state that could be compared). The f-values for the Swan, Deslandres-d'Azambuia, Mulliken, Fox-Herzberg, Phillips, and Ballik-Ramsay transitions are calculated as f = 0.048 (experimental 0.034), f = 0.0650, f = 0.1025, f = 0.8184, f = 0.0027, and f = 0.0066, respectively. The f-values for three additional, yet unknown, transitions between low-lying states are also reported.

2336 ACCURATE PARTITION FUNCTIONS IN THE DETERMINATION OF THE C_2 ABUNDANCE. E.Clementi.
Astrophys. J. (USA), Vol. 133, No. 1, 303-8 (Jan., 1961).
Recent theoretical and experimental data on the diatomic carbon molecule make feasible an accurate calculation of the partition function at high temperatures. All the excited states which contribute to the partition function have been considered. A table of thermodynamic functions in the temperature range 2000°-6000°K is given. The results so obtained are used in the recalculation of the molecular abundance, S, as defined by Russell, Roach, and Hunaerts. In the solar reversing layer the molecular abundance was found to be log S = 12.83. The rotational lines of the 0—0 band in the Swan system are used to obtain the molecular abundance. The oscillator strength of the Swan system was taken as f = 0.04 and the molecular excitation temperature as T = 4500°K. The results indicate the importance of accurate partition-function calculations in the determination of the molecular abundance.

2337 DYNAMICAL JAHN—TELLER EFFECT IN HYDROCARBON RADICALS. W.D.Hobey and A.D.McLachlan.
J. chem. Phys. (USA), Vol. 33, No. 6, 1695-703 (Dec., 1960).
It is shown how the ordinary Born—Oppenheimer approximation for separating nuclear and electronic motion can be adapted to a degenerate electronic state. To set up equations of motion for the dynamical Jahn—Teller effect in their simplest form vibrational amplitudes are used associated with special linear combinations of the degenerate electronic wave-functions, chosen to vary as slowly as possible with nuclear displacements. The symmetry-forbidden electronic transitions allowed by a Jahn—Teller distortion are discussed briefly. Molecular orbital calculations are made of the energies and distorted shapes of some aromatic hydrocarbon molecules. The differences in energy between the distorted and symmetrical shapes (in kcal/mole) are cyclobutadiene 11.43; cyclopentadienyl 1.414; cycloheptatrienyl 0.859; benzene negative

ion 1.077; triphenylene and coronene negative ions 0.385 and 0.299. In the last three each shape of minimum energy is separated from two equivalent ones by a small potential barrier, respectively, 0.000, 0.001, and 0.002. The ground state of each radical is doubly degenerate, and it can oscillate about a continuous series of distorted shapes. In the excited $^1E_{1u}^+$ and $^3E_{1u}^+$ states of benzene the distortions are much smaller, and the CC bonds probably bend rather than stretch.

2338 ENERGY LEVELS IN NITROGEN TETROXIDE. M.Green and J.W.Linnett.
Trans Faraday Soc. (GB), Vol. 57, Pt 1, 10-13 (Jan., 1961).

The nature of the N—N bond in N_2O_4 is investigated by means of a LCAO MO calculation. It appears that this bond is mainly σ in nature, not of pure π character, as proposed by Coulson and Duchesne (Abstr. 8397 of 1958). A skew configuration is found to be less favourable for the molecule from an energy point of view.

RECENT APPEARANCE POTENTIAL MEASUREMENTS USING AN ELECTROSTATIC ELECTRON SELECTOR. See Abstr. 1887

2339 THE ELECTRONIC STRUCTURE OF NITROGEN DIOXIDE M.Green and J.W.Linnett.
Trans Faraday Soc. (GB), Vol. 57, Pt 1, 1-9 (Jan., 1961).

A LCAO MO calculation is made. The relationship of the orbital energies to the Coulomb and resonance integrals is discussed. It seems that the unpaired electron lies in the $4a_1$ level, not in the $1a_2$ orbital proposed by Coulson and Duchesne (Abstr. 8397 of 1958). The calculated orbital energies are compared with ionized potentials

2340 π-ELECTRON THEORY. H.Hartmann.
Z. Naturforsch. (Germany), Vol. 15a, No. 11, 993-1003 (Nov., 1960). In German.

By the inclusion of higher atomic states, the Hückel theory of π-electron systems is expanded and an explanation for Scheibe's phenomenon obtained. [Z. Elektrochem. (Germany), Vol. 54, 403, (1959); Vol. 63, 117, (1959)]. In addition, the theoretical concept of resonance-energy is placed on a sounder basis than hitherto, since the well-known discrepancies that occur when resonance energies, E_S, obtained from wave-mechanical studies are compared with those obtained from thermodynamic studies disappear; e.g. E_S(theor.) and E_S(expt.) for naphthalene are 2.9 and 3.3 eV and for phenanthrene 5.6 and 5.6 eV, respectively.

W.J.Orville-Thomas

2341 HALOGEN BOND CHARACTER IN THE ALKYL HALIDES. B.P.Dailey.
J. chem. Phys. (USA), Vol. 33, No. 6, 1641-3 (Dec., 1960).

The quantity $(I + s^2)$, the sum of the ionicity and s hybridization, is calculated from nuclear quadrupole coupling data for 24 alkyl halides. The ionicity is estimated independently from calculated values of ϵ_X, the effective charge on the halogen. The average derived values of s^2, the amount of s character in the hybrid halogen bonding orbital, are 13.6% for carbon—chlorine bonds, 8.6% for carbon—bromine bonds, and 1.8% for carbon—iodine bonds.

2342 CALCULATION OF THE ENERGY LEVELS AND WAVE-FUNCTIONS OF DISUBZTITUTED BENZENE MOLECULES USING THE "METALLIC MODEL". A.F.Terpugova.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 162-5 (Aug., 1960). In Russian.

The "metallic model" method was used to calculate the energy levels, the frequencies of transitions represented by the longest wavelengths, and the electron-density distribution for the para-, ortho-, and meta-isomers of $C_6H_4Cl_2$, $C_6H_4Br_2$ and $C_6H_4(NO_2)_2$. Fair agreement between the calculated and experimental absorption-band frequencies was obtained and an interpretation of these bands is given. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 86-7 (Aug., 1960)]. A.Tybulewicz

2343 A QUANTUM-MECHANICAL ALLOWANCE FOR NON-LINEARITY OF A MOLECULE. S.M.Yazýkova.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 517-19 (Oct., 1960). In Russian.

The metallic molecular model is modified by a quantum-mechanical allowance for non-linearity of molecules. The new approach is illustrated on the butadiene molecule. [English translation in: Optics and Spectrosc. (USA)]. Vol. 9, No. 4, 269-70 (Oct., 1960).

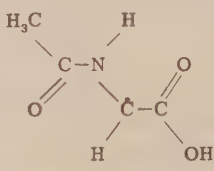
A.Tybulewicz

2344 CALCULATION OF THE OPTICAL ACTIVITY OF MOLECULES.
M.V.Vol'kenshtein and M.P.Kruchek.
Optika i Spektrosk. (USSR), Vol. 9, No. 4, 467-71 (Oct., 1960). In Russian.

A theoretical calculation of the optical activity is illustrated on 3-methylcyclopentanone. It is shown that polarization interactions between the constituent groups of the molecule govern its optical activity. [English translation in: Optics and Spectrosc. (USA)]. Vol. 9, No. 4, 243-5 (Oct., 1960). A.Tybulewicz

2345 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF N-ACETYLGLYCINE.
I.Miyagawa, Y.Kurita and W.Gordy.
J. chem. Phys., Vol. 33, No. 6, 1599-1603 (Dec., 1960).

Electron spin resonance absorption of an irradiated single crystal of N-acetylglycine was observed at room temperature at 9 kMc/s and 12 kMc/s. From the analysis of the anisotropy in the spectroscopic splitting factor and in the nuclear hyperfine interaction constant, a chemical structure



is deduced for the free radical. The C—H bond is in the NCC plane and approximately along the bisector of the NCC angle. The unpaired electron spin density is essentially in a π orbital, about 72% of which is the p orbital of the CH carbon directed perpendicular to the NCC plane.

2346 ELECTRON RESONANCE STUDY OF THE CARBOXYLATE HYDROXY METHYL RADICAL ION.
N.M.Atherton and D.H.Whiffen.
Molecular Phys. (GB), Vol. 3, No. 1, 103-4 (Jan., 1960).

The hyperfine coupling parameters and the g-tensor were measured for the radical ion $HOCHCO_2^-$, produced by γ-irradiation of a single crystal of potassium glycollate, and the values compared with those for the radical HOCHCOOH.

E.F.W.Seymour

2347 NUCLEAR MAGNETIC INTERACTIONS IN HYDROGEN FLUORIDE.
M.R.Baker, H.M.Nelson, J.A.Leavitt and N.F.Ramsey.
Phys. Rev. (USA), Vol. 121, No. 3, 807-15 (Feb. 1, 1961).

The radiofrequency spectra corresponding to the reorientation of the proton and fluorine nuclear magnetic moments in HF were observed in fields of 900, 1800, and 3600 G by means of the molecular beam resonance method. Details are presented on the design and construction of the new molecular beam apparatus and electron bombardment detector used in the experiment. The theory of the HF strong-field energy levels is outlined, and the expected proton and fluorine transitions derived for J = 0, 1, and 2 are tabulated. From the observed resonance shapes, one can deduce the magnitude of the spin—rotational interactions of the proton and fluorine nuclei and their spin—spin interaction. These are: $|c_p| = 71 \pm 3$ kc/s, $|c_F| = 305 \pm 2$ kc/s, $d_1 = 57 \pm 2$ kc/s. The correctness of these parameters was checked by the good agreement between the experimental curves and resonance shapes predicted by Univac programs using these values. The observed fluorine spin—rotational interaction constant is the largest yet observed and corresponds to a rotational magnetic field at the nucleus of 76 G per unit rotational quantum number. The implications of the large spin—rotational interaction for relaxation processes in nuclear magnetic resonance experiments are discussed.

2348 THE EFFECT OF VIBRATIONS ON THE [NUCLEAR] QUADRUPOLE COUPLING CONSTANTS OF ALKALI-HALIDE MOLECULES. A.G.Makhan'ek.
Optika i Spektrosk. (USSR), Vol. 9, No. 3, 412-15 (Sept., 1960). In Russian.

Dependence of the nuclear quadrupole coupling constants on the vibrational state is shown to be related to a small admixture of covalent binding in these predominantly ionic compounds. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 3, 214-15 (Sept., 1960)]. A.Tybulewicz

2349 N.M.R. SECOND MOMENT OF A RADICAL UNDER THE RESTRICTED ROTATION.
iyake, R.Chûjô and H.Adachi.
hys. Soc. Japan, Vol. 14, No. 7, 972 (July, 1959).
Unlike Gutowsky et. al. (Abstr. 5180 of 1950), the authors find nstant second moment by substituting a different expression into wsky's formula. J.M.Baker

2350 C^{13} CHEMICAL SHIFTS IN CO AND CO_2.
R.Ettinger, P.Blume, A.Patterson, Jr and P.C.Lauterbur.
hem. Phys. (USA), Vol. 33, No. 5, 1597-8 (Nov., 1960).
The nuclear magnetic resonance of C^{13} in 61% abundance in eous carbon monoxide was found to occur 57.1 ± 0.3 p.p.m. on low field side of the resonance in carbon dioxide under the same ditions. E.F.W.Seymour

2351 PROTON MAGNETIC RESONANCE STUDIES OF UNSATURATED AND AROMATIC COMPOUNDS WITH PARULAR REGARD TO EFFECTS OF ELECTRON DELOCALIZAN. R.A.Hoffman.
. Kemi (Sweden), Vol. 17, Paper 1, 1-23 (1960).
Some recent developments in methods of analysing spectra are ussed, and a review is given of various effects of electron delozation on proton magnetic resonance spectra. This treatment udes the ring current effect in aromatic compounds, substituent cts on chemical shifts in unsaturated and aromatic compounds, isotropic contact shifts in paramagnetics. The importance of tron delocalization in electron contact coupling of nuclear spins ointed out and it is shown that certain long-range couplings in matic systems are not in agreement with predictions based on mechanism. Selected problems concerning structure deterations in unsaturated and aromatic compounds are discussed. refs.

2352 PREDISSOCIATION IN THE HNO MOLECULE.
M.J.Y.Clement and D.A.Ramsay.
ad. J. Phys., Vol. 39, No. 1, 205-9 (Jan., 1961).
Twelve bands of HNO and 18 bands of DNO in the region 6000 to 00 A were photographed in emission during the reactions of ogen and deuterium atoms with nitric oxide. Two of the HNO ls and 3 of the DNO bands show a sharp breaking-off in the otational structure, due to predissociation of the molecule in excited state. Upper limits for the dissociation energies of HNO DNO are 48.6 kcal/mole and 49.1 kcal/mole respectively.

2353 STATISTICAL MECHANICS OF MOLECULAR IONS.
R.N.Varney.
nem. Phys. (USA), Vol. 33, No. 6, 1709-11 (Dec., 1960).
The N_4^+ ion is shown to be able to be in equilibrium against ociation into N_2^+ and N_2 under specified experimental conditions if it possesses a considerable degree of vibrational excitation. A_2^+ ion, lacking the numbers of modes of vibrational freedom essed by the N_4^+, is therefore unstable under the same condis. It would become stable in much weaker electric fields and ltaneously higher pressures. Experimentally, the A_2^+ ion is rn to exist in contradiction to this prediction, but theoretical experimental evidence is advanced that it is metastable and subto dissociation with sufficient numbers of collisions in the gas.

DRIFT VELOCITIES OF SLOW ELECTRONS IN HYDROGEN, NITROGEN. See Abstr. 2300

2354 THE VAN DER WAALS INTERACTION OF PARTICLES.
R.Sanker.
J. Indian Inst. Sci. Vol. 42, No. 1-2, 17-22 (Jan.-April, 1960).
Calculates the interaction energies of ellipsoidal particles whose elements interact according to an inverse power of their distance apart. H.N.V.Temperley

2355 NOTE ON THE EFFECT OF OXYGEN MOLECULES CONTAINED IN SOLID HYDROGEN ON THE RATE OF ORTHO–PARA CONVERSION. K.Motizuki and T.Nagamiya.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1639-40 (Nov., 1959).
An earlier theoretical study of the effect of dissolved oxygen on ortho–para conversion in solid H_2 and solid D_2 (Abstr. 2274, 6990 of 1956; 5455 of 1958) is extended to take into account the change in direction of the oxygen spin during the conversion process. The theoretical conversion rates are found to be substantially increased by this extra factor. L.Mackinnon

2356 MASS SPECTROMETRIC STUDY OF HEATS OF DIMERIZATION OF ALKALI CHLORIDES.
T.A.Milne and H.M.Klein.
J. chem. Phys. (USA), Vol. 33, No. 6, 1628-37 (Dec., 1960).
The heats of sublimation of the important species in equilibrium with the five alkali chlorides were determined using the Bendix time-of-flight mass spectrometer. The mass spectrometrically determined differences between the heats of sublimation of monomer and dimer have been combined with the best available value for the monomer heat of sublimation to calculate the dimerization energies for all five salts. For LiCl a trimerization energy was also determined. These results are compared with the results of previous studies.

2357 MOLECULAR SIZE DISTRIBUTION AND GELATION OF IRRADIATED COPOLYMERS. M.Inokuti.
J. chem. Phys. (USA), Vol. 33, No. 6, 1607-15 (Dec., 1960).
A theory is developed about the molecular size distribution in a system of copolymers which are composed of two different kinds of monomer units and undergo random crosslinking when exposed to high-energy radiations. The radiation-induced change in the molecular size distribution is decribed by an integro-differential equation, which is solved exactly by means of Laplace transform for an arbitrary initial distribution to obtain the number average as well as the weight-average degree of polymerization as a function of radiation dose. Further, the gel point, or the dose required for incipient gelation, is given as a function of concentrations of the monomer units constituting the copolymeric system. The present theory, which also involves the problem of crosslinking in a mixture of two kinds of polymers as a special case, leads to a condition for gelation of such a mixture due to irradiation when crosslinking competes with main-chain scission. This condition proves to be completely independent of the initial distribution.

2358 VELOCITY ANALYSIS OF MOLECULAR BEAMS GENERATED FROM NaOH VAPORS.
V.S.Rao and R.C.Schoonmaker.
J. chem. Phys. (USA), Vol. 33, No. 6, 1718-20 (Dec., 1960).
A molecular beam velocity analysis technique was employed to determine the molecular composition of vapours in equilibrium with liquid sodium hydroxide in the temperature range 887-996°K. The experimental results are nonreproducible to an extent which far exceeds the expected experimental uncertainties. It is inferred that this anomalous behaviour is characteristic of the NaOH system and several possible explanations for the discrepancies are discussed.

SOLID-STATE PHYSICS

2359 UKRAINIAN CONFERENCE ON THE THEORY OF METALS AND ALLOYS.
V.M.Danilenko, M.A.Krivoglaz, L.N.Larikov and A.A.Smirnov.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 1, 191-8 (Jan., 1960).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 1, 78-83 (July-Aug., 1960).
Held in Kiev, on 1-5 June, 1959. Seventy papers were presented.

2360 CONFERENCE ON THE PHYSICS OF ALKALI-HALIDE CRYSTALS. E.Klement and Ch.Lushchik.
Uspekhi fiz. Nauk (USSR), Vol. 70, No. 4, 733-8 (April, 1960). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 3, No. 2, 273-7 (Sept.-Oct., 1960).
Held in Tartu, on 30 June to 4 July 1959. Thirty-six papers were presented, grouped around three topics: local states in crystals - luminescence and colour centres; electron—hole and exciton processes; crystalline structure - ionic and dislocation processes.

2361 GROUP THEORY IN SOLID-STATE PHYSICS.
D.F.Johnston.
Rep. Progr. Phys. (GB), Vol. 23, 67-153 (1960).
The concept of a vector space irreducible under a set of operators is developed from first principles, and then introduced into the many-particle formalism of quantum mechanics by means of an explicit postulate of irreducibility. The calculus of the irreducible matrix representations of finite groups is developed ab initio, including the theory of characters and projection operators. The use of this calculus to simplify eigenvalue calculations is explained in detail. In the second part of the paper, the structure of the general crystal space group, including glide-planes and screw-axes, is discussed briefly. The theory is developed of the symmetry group of a many-electron system with spin—orbit coupling, using the Dirac formalism. A detailed discussion is given of Signer's time-reversal theorems for a many-electron system, including the character tests for time-reversal degeneracy. A general theory of the permutation symmetry of a many-electron system is developed, and shown to contain the Dirac vector model as a special case. A new treatment is given of the theory of the irreducible representations of space groups, including the double space groups and Herring's time-reversal theorems.

STRUCTURE OF THE GENERAL CRYSTAL SPACE-GROUP.
See Abstr. 2361

2362 THE THEORY OF ORIENTATIONAL ORDERING OF POLAR CRYSTALS. V.I.Klyachkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 7, 1390-8 (July, 1960).
In Russian.
The theory is developed allowing for short-range orientational forces and long-range forces of the dipolar type between molecules. Using methods due to Bogolyubov, the point of phase transitionis determined and the temperature dependence of dielectric permittivity investigated. The question of the relative contribution of dipolar forces to correlation effects in molecular orientation is clarified. Some applications to HI and HBr are briefly considered. [English translation in: Soviet Physics—Solid State (USA)].
R.F.S.Hearmon

2363 EFFECTIVE CHARGES OF THE IONS IN ALKALI HALIDE CRYSTALS. DUPLICATION OF THE FREQUENCIES OF OSCILLATIONS OF THE OPTICAL BRANCH.
N.Boccara.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1485-6 (Oct. 10, 1960).
In French.
An expression is derived for the effective electric charge as a function of the ratio of the frequencies of the long wavelength optical modes. J.W.Leech

2364 THE WAVE-FUNCTIONS OF THE VALENCE BOND IN CERTAIN CRYSTALS. A.I.Gubanov and O.E.Pushkarev.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 8, 1776-82 (Aug., 1960).
In Russian.
Approximate wave-functions are proposed for the valence electrons of several atoms. These are then used to derive, by a variational method, the one-electron wave functions for the valence bonds of a crystal of the diamond type. A numerical answer is obtained for germanium and in the approximation used this agrees reasonably with the linear combination of atomic functions. [English translation in: Soviet Physics—Solid State (USA)].
M.G.Priestle

2365 BONDING IN CRYSTALS WITH "NORMAL VALENCY", WITH SPECIAL REFERENCE TO ZnS AND WURTZITE STRUCTURES. O.G.Folberth.
Z. Naturforsch. (Germany), Vol. 15a, No. 5-6, 425-31 (May-June, 1960). In German.
Reconsiders the evidence on whether the bonding in these crystals is more ionic in character than covalent. J.E.Caffyn

2366 FILLED AND EMPTY DANGLING BONDS IN III—V COMPOUNDS. D.B.Holt.
J. appl. Phys. (USA), Vol. 31, No. 12, 2231-2 (Dec., 1960).
It is pointed out that the model of dangling bonds from the {111} and {$\bar{1}\bar{1}\bar{1}$} surfaces of III—V compounds proposed by Gatos, Moody, and Lavine is open to serious objection. The idea of resonance is introduced in order to develop a model which is not subject to the same difficulties. Certain implications of this model for dislocation theory are discussed.

2367 DIRECT MEASUREMENTS OF THE SURFACE ENERGIES OF CRYSTALS. J.J.Gilman.
J. appl. Phys. (USA), Vol. 31, No. 12, 2208-18 (Dec., 1960).
By means of quantitative cleavage experiments, the surface energies of several simple crystals have been measured at −196°C. The crystals and their cleavage planes are: LiF (100), MgO(100), CaF_2(111), BaF_2(111), $CaCO_3$(1010), Si(111), and Zn(0001). Measured values of their respective surface energies (ergs/cm^2) are: 340, 1200, 450, 280, 230, 1240, and 105. The measured values for LiF and MgO are in good agreement with simple ionic lattice theory. Values for the other crystals seem consistent with their binding energies. Under irreversible conditions an effective surface energy is measured. This quantity increases rapidly with increasing temperature for the metallic crystals, Zn and Fe(3% Si). The increase correlates with increasing plastic flow in these crystals. In contrast the effective surface energy of LiF and MgO is only moderately dependent on temperature. A small amount of cadmium (0.1 at.%) markedly increases the cleavage surface energy of zinc.

LATTICE MECHANICS

2368 GREEN'S FUNCTIONS FOR MONATOMIC SIMPLE CUBIC LATTICES. A.A.Maradudin, E.W.Montroll, G.H.Weiss, R.Herman and H.W.Milnes.
Mem. Acad. Roy. Belgique Cl. Sci. (Coll. in 4°), Vol. 14, No. 7, 176 pp. (1960).
A tabulation to six significant figures of the Green's functions for monatomic simple cubic lattices which are defined by the integral

$$I(a, b, c\,;\alpha\,;\beta) = \frac{1}{\pi^3}\int_0^{\pi}\int_0^{\pi}\int_0^{\pi} \frac{\cos ax \cos by \cos cz}{(2+\alpha)\beta - \cos x - \cos y - \alpha \cos z}\,dx\,dy\,dz$$

is presented for the following ranges of parameters :

$$\mu = \beta^{-1} = 0.00(0.01)1.00\,; \qquad \alpha = 1, 2, 4, 8, 16\,;$$

$$0 \le a^2 + b^2 + c^2 \le 15.$$

The recurrence formula satisfied by this integral, closed-form expressions for the integral for special values of the parameters, asymptotic expressions valid in different ranges of the parameters and examples of the applications of these tables are presented.

2369 THERMODYNAMIC GREEN'S FUNCTION METHODS IN NEUTRON SCATTERING BY CRYSTALS. G.Baym.
Phys. Rev. (USA), Vol. 121, No. 3, 741-7 (Feb. 1, 1961).
Formulae are derived for the transition probabilities per unit time for both inelastic coherent scattering of neutrons by crystals and resonant emission of photons and neutrons by nuclei bound in

als, without making the assumption that the crystal is onic. In deriving these transition probabilities, the analytic ture of thermodynamic correlation or Green's functions, dered as functions of complex temperatures and times, is oped and used. In particular a spectral form is found for the on Green's function. Only one assumption is made about the al, namely that the displacement of the nuclei due to the s exerted by the neutron in scattering are linear functions of forces. This leads to an evaluation of the transition abilities in terms of the exact thermodynamic displacement orrelation function. This evaluation obeys the detailed cing condition, and Placzek's sum rule. A consequence of evaluation is that the widths of the "one-phonon" peaks in the on scattering are exactly equal to the widths of the correspond-honon states of the crystal.

370 APPLICATION OF THE THEORY OF VIBRATIONS OF A CRYSTAL LATTICE WITH DEFORMABLE IONS TO CONSIDERATION OF THE PHYSICAL PROPERTIES OF RY CUBIC CRYSTALS. K.B.Tolpygo.
Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 177-88; Disc. 212-13 0). In Russian.
"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of). The dimensionless parameters entering the theory can be ved either from data on dispersion, or from ϵ, n_0^2 and the pressibility, or from ϵ, n_0^2 and the frequency ω_g corresponding e maximum infrared absorption. These data are tabulated for ystals (18 alkali halides, TlCl, TlBr, AgCl, AgBr, MgO, CaO, . The calculated elastic moduli are compared with the experi-al values and the agreement is best for alkali halides with ions milar sizes. Taking account of non-central and van der Waals es, etc., does not bring about general agreement. R.Berman

371 NATURE OF VIBRATIONAL MODES IN IONIC CRYSTALS. H.B.Rosenstock.
. Rev. (USA), Vol. 121, No. 2, 416-24 (Jan. 15, 1961).
The following is found: (1) Waves in lattices are in general er transverse nor longitudinal; in particular, they need not be verse or longitudinal when the propagation vector $\vec{k}$ is very l. (2) The relationship $\omega_l/\omega_t = (\epsilon_0/\epsilon_\infty)^{1/2}$ for "longitudinal" and nsverse" modes in ionic crystals applies, if at all, in a region nall, but nonzero, wave vector $\vec{k}$. (3) The derivation of this ionship is based, at least implicitly, on the use of cyclic dary conditions. (4) The use of cyclic boundary conditions is in statistical problems for crystals without long-range forces, as never been justified for systems with Coulomb forces. cyclic boundary conditions are nonetheless used, it can be ly shown that for $\vec{k} = 0$, $\omega_l/\omega_t = 1$.

372 THE EFFECT OF [VIBRATIONAL] ANHARMONICITY ON THE THERMAL SCATTERING OF X-RAYS IN TALS. H.Hahn and W.Ludwig.
ys. (Germany), Vol. 161, No. 4, 404-23 (1961). In German.
he effect is calculated for temperatures above the Debye rature. A revised method of interpreting the experimental s suggested. The (temperature dependent) dispersion curves ency versus wave-vector) for small wave-vectors are deter- by the isothermal rather than the adiabatic elastic constants. cedure is outlined to extrapolate from the (temperature depen-scattering data the (temperature independent) dispersion curves correspond to the harmonic approximation.

373 THEORY OF ELECTRON–PHONON INTERACTIONS. G.D.Whitfield.
Rev. (USA), Vol. 121, No. 3, 720-34 (Feb. 1, 1961).
he theory of the interaction of electrons and acoustic as in nonpolar crystals is formulated in terms of a new set is states, whose wave functions are essentially Bloch functions eform with the lattice. The major part of the interaction may e calculated in terms of the strain tensor rather than the cement of the lattice. A result of the theory is a generaliza-f the deformation potential theorem.

374 INTERACTION OF ELECTRONS WITH LATTICE VIBRATIONS IN HOMOPOLAR CRYSTALS: ACOUSTIC SSTRAHLUNG FROM AN ACCELERATED ELECTRON.
enberg.
hys. (Germany), Vol. 7, No. 1-2, 8-16 (1960). In German.
he interaction between electrons and lattice vibrations is established quantum mechanically using the method of Bardeen and Shockley (Abstr. 1057 of 1951). The classical field equation for this interaction is given using the continuum approximation for the lattice vibrations. The field equation is solved in the dipole approximation for an accelerated electron and the acoustic bremsstrahlung calculated for a given trajectory. Due to the magnitude of this energy loss there is an appreciable capture probability for electrons by positively charged defects.
J.W.Leech

2375 THE DEPENDENCE OF THE PHONON SPECTRUM ON THE CONCENTRATION OF FREE CURRENT CARRIERS. V.L.Bonch-Bruevich.
Fiz. tverdogo Tela (USSR), Vol. 2, No 8, 1857-63 (Aug., 1960). In Russian.
The method of the temperature quantum Green's function is used to solve the problem of the spectrum of acoustic phonons which interact with the free current carriers. Explicit formulae are obtained which are valid for any temperature and for any degree of degeneracy of the electron gas. The velocity of sound is found to depend on the concentration of free electrons, and, if the dispersion law for the electrons is known, it is possible to determine experimentally the constants of the deformation potential. [English translation in: Soviet Physics–Solid State (USA)]. M.G.Priestley

2376 SCATTERING OF ELECTRONS ON THE ACOUSTIC MODES OF LATTICE VIBRATIONS IN HEXAGONAL CRYSTALS. E.P.Pokatilov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2210-13 (Sept., 1960). In Russian.
The deformation potential method was used to calculate the components of the relaxation-time tensor for this scattering process. [English translation in: Soviet Physics–Solid State (USA)].
A.Tybulewicz

2377 USE OF THE DENSITY-MATRIX METHOD IN DEALING WITH CONDUCTION ELECTRONS INTERACTING WITH LATTICE VIBRATIONS. I.G.Lang.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2330-40 (Sept., 1960). In Russian.
The Kohn and Luttinger density-matrix method (Abstr. 5866 of 1958) is used in its lowest approximation to deal with the interaction of conduction electrons with thermal lattice vibrations. It leads to the usual system of kinetic equations allowing for drag of phonons by electrons and of electrons by phonons. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

Thermal Properties

2378 FREQUENCY DISTRIBUTION AND THE SPECIFIC HEAT OF NaCl AT LOW TEMPERATURES. E.M.Arase and R.D.Hatcher.
J. chem. Phys. (USA), Vol. 33, No. 6, 1704-8 (Dec., 1960).
Using the Kellerman model of the NaCl crystal, the eigenfrequencies at 0°K are found from those at room temperature by a first-order perturbation theory, which is developed here. From this the frequency distribution at 0°K is obtained and is compared with the room-temperature frequency spectrum. The specific heat and apparent Debye temperatures below 100°K based on both distributions as well as linearly weighted average are given.

2379 HEAT CAPACITY OF ICE AT LOW TEMPERATURES. P.Flubacher, A.J.Leadbetter and J.A.Morrison.
J. chem. Phys. (USA), Vol. 33, No. 6, 1751-5 (Dec., 1960).
The heat capacity of normal hexagonal ice was measured over the temperature range 2° to 27°K with an estimated precision varying between ±2% at the lowest temperatures and ±0.2% at the higher temperatures. The results agree satisfactorily with those of earlier measurements in the region $T > 10°$K, and do not significantly affect the value of the residual entropy of ice calculated by Giauque and Stout (1936). Although the new results do not influence the existing thermodynamic description of ice, they provide information which is important in understanding its vibrational properties. In the first place, extrapolation of the results to $T = 0°$K yields a value of Θ_0, the Debye characteristic temperature corresponding to continuum behaviour. This is found to agree satisfactorily with Θ (elastic) estimated from the elastic constants of ice. In the second place, complete $\Theta_D(T)$ curves can be constructed, and an examination of

these, computed for different sizes of vibrational unit, enables the gross features of the lattice frequency spectrum of ice to be determined. The conclusion reached is that the three components of the spectrum, due respectively to translational and rotational vibrations of the water molecule and to intramolecular vibrations, are well separated. The contribution of the librational modes to the thermodynamic properties can be approximated rather well by a single frequency of 620 cm^{-1}.

2380 THE HIGH TEMPERATURE HEAT CONTENT OF SODIUM OXIDE. R.T.Grimley and J.L.Margrave.
J. phys. Chem. (USA), Vol. 64, No. 11, 1763-4 (Nov., 1960).

Experimental values for the heat content of purified Na_2O (96.76% Na_2O, 2.33% Na_2CO_3 and 0.91% Na_2O_2) obtained using a copper-block drop-type calorimeter [Margrave and Grimley, J. phys. Chem. (USA), Vol. 62, No. 11, 1436 (Nov., 1958)] are listed. The heat content data are represented by $H_{(T)} - H_{(298.15)} = 14.99\,T + 4.94 \times 10^{-3} T^2 - 4799$ cal $mole^{-1}$ over the temperature range 298° to 1170° K to within ±2%. The heat contents, entropies and free energy functions calculated at 100° K intervals from this relation and $S_{298} = 17.99$ e.u. are also listed. S.Weintroub

HEAT CAPACITY OF FERROMAGNETIC SUPERCONDUCTORS. See Abstr. 1863

2381 THERMAL CONDUCTIVITY OF α- AND β-MODIFICATIONS OF In_2Te_3.
A.I.Zaslavskii, V.M.Sergeeva and I.A.Smirnov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2885-93 (Nov., 1960).
In Russian.

The lattice thermal conductivity (k) of β-In_2Te_3 was low because of the strong scattering of phonons on randomly distributed vacancies in the indium sublattice. Annealing raised the value of k (by ordering cation defects) and saturation was reached when In_2Te_3 assumed the α-form. Behaviour of k reflected the reversible $\alpha \rightleftharpoons \beta$ transition. The rate of formation of the α-form during annealing depended on crystal dimensions: the larger the crystal the lower the rate. The thermal conductivity results agreed quite well with those obtained by X-ray diffraction. [English translation in: Soviet Physics — Solid State (USA)]. A.Tybulewicz

ELECTRON STATES

2382 REACTION KINETICS OF ELECTRON PROCESSES IN SOLIDS.
Abhandl. Deutschen Akad. Wiss. Berlin Kl. Math. Phys. Tech. (1960) No. 7, 319 pp. In German.

Proceedings of a meeting of the Deutsche Akademie der Wissenschaften zu Berlin, 11-13 April 1960. Twenty-six papers were presented, abstracts of which will appear (under the appropriate headings) in this or succeeding issues of "Physics Abstracts".

2383 EXPERIMENTAL ANALYSIS OF THE ELECTRONIC STRUCTURE OF METALS. A.B.Pippard.
Rep. Progr. Phys. (GB), Vol. 23, 176-266 (1960).

After a short summary of the general ideas and assumptions of the independent-particle model of a metal, an account is given of the experimental methods which have been, or may be, used to determine the details of the model for any given metal, with special reference to the shape of the Fermi surface and the electronic velocity at all points on the Fermi surface. Particular attention is paid to the exposition of the theory underlying each method, and as far as possible only simple mathematical and physical ideas are used. The conditions of application of the methods are discussed, and examples are given of the results so far obtained by their use, with special emphasis on the analysis of the electronic structure of copper. The methods discussed are the following: magnetoresistance, de Haas–van Alphen and Schubnikov effects, anomalous skin effect, cyclotron resonance, ultrasonic attenuation and magnetoacoustic effects, size effects.

2384 EFFECT OF SPIN–ORBIT SPLITTING ON THE FERMI SURFACES OF THE HEXAGONAL-CLOSE-PACKED METALS. M.H.Cohen and L.M.Falicov.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 544-6 (Dec. 15, 1960).

It is pointed out that because of spin–orbit coupling, the zones in h.c.p. metals will not stick together in pairs over the whole (0001) face, but only along certain symmetry lines. The maximum splittings occur at the corners of the face, and are estimated to range from about 10^{-5} eV for Be to 10^{-1} eV for Tl; detailed figures are given for Mg. Alloy theory is not greatly affected, but the changed Fermi-surface topology considerably alters the interpretation of, for example, magnetoresistance data.
R.G.Chambe

FERMI SURFACE AND ELECTRON STATES IN BISMUTH. See Abstr. 2046

2385 INVESTIGATION OF THE SPECTRA OF PLASMONS. V.N.Ageev, L.A.Balabanova and M.M.Bredov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2899-906 (Nov., 1960).
In Russian.

An accurate method for studying plasmon spectra is describe For Al the value $\hbar\omega = 15.18 \pm 0.06$ eV is obtained, with a probabili of 0.9 that the value lies in the given range. This is close to the value of 15.48 eV derived from a free electron gas model, taking into account the polarizability of the ion cores. In some cases the difference between the theoretical value and the experimental can be used to determine the polarizability. From line intensity measurements the ratio of the electron path for excitation of plasmons to the film thickness can be derived. In Al, for 14.5 keV electrons this ratio is 0.75 and the corresponding path is 200-650 (the uncertainty is due to the uncertainty in the film thickness, determined interferometrically). [English translation in: Soviet Physics — Solid State (USA)]. R.Berm

DEFECT PROPERTIES

2386 A GENERAL DISCUSSION ON CRYSTAL IMPERFECTIONS AND THE CHEMICAL REACTIVITY OF SOLI
Disc. Faraday Soc. (GB), No. 28, 1-252 (1959).

The discussion took place on Sept. 2-4, 1959, at Queen's Un versity, Kingston, Ontario, at the invitation of the Natural Resea Council (Ottawa), Queen's University, and the Royal Military Col Kingston, with the support of Atomic Energy of Canada Ltd. and Canadian Industries. 24 papers were presented, followed by ext sive discussions grouped into four sections. Abstracts of some the main papers will appear in this or subsequent issues of "Ph Abstracts".

2387 THE PROBLEM OF RATIONAL LATTICE DEFECT CLASSIFICATION. W.Schottky.
"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 235-
In German.

Deals with the concepts and the symbols of the statistical the of lattice defects. Methods are developed for the calculation of chemical potentials of the lattice molecule μ_M and of various lat defects μ_i, once the statistical free energy and the Gibbs free energy are known, and for the calculation of the equilibrium con centration. The dependence of μ_M on the concentrations of vario lattice defects is examined, and the "zero defects" which origina in perfect lattices are investigated. The theory of Kröger and Vi is critically considered and replaced by the author's new syste with its symbols and concepts. A.Landr

2388 CHANGES IN MACROSCOPIC SHAPE, LATTICE PA METER, AND DENSITY IN CRYSTALS DUE TO PO DEFECTS. R.W.Balluffi and R.O.Simmons.
J. appl. Phys. (USA), Vol. 31, No. 12, 2284-8 (Dec., 1960).

It is demonstrated that a crystal of arbitrary shape filled w fine random distribution of centres of dilatation will dilate homo geneously. No elastic approximations are made, and the results should hold for strains of any magnitude. By use of an average perfect reference lattice embedded in the strained crystal, it is shown that the lattice dilatation as measured by X-ray lattice pa meter measurements and by macroscopic dimensional measure should be the same along any direction when the number of subs tutional atomic sites remains constant. Perturbing effects due t X-ray diffuse scattering should cause negligible error in determ the positions of the Laue–Bragg maxima under usual conditions results should apply also to the case of thermal dilatation at te

ures up to the melting point. The use of density measurements determination of point defect concentrations is discussed. imental data are reviewed.

89 PRODUCTION OF DISLOCATION LOOPS BY A COMBINED CLIMB AND GLIDE MECHANISM.
ourie and H.G.F.Wilsdorf.
l. Phys. (USA), Vol. 31, No. 12, 2219-23 (Dec., 1960).
tudies of dislocations in elongated aluminium crystals by diffn electron microscopy revealed narrow dislocation loops parallel to ⟨112⟩. These loops formed only behind screw disons, their long parts then having edge character. Four anisms have been proposed to account for the formation and ization of the narrow loops through the condensation of point ts.

390 GOLD-INDUCED CLIMB OF DISLOCATIONS IN SILICON. W.C.Dash.
l. Phys. (USA), Vol. 31, No. 12, 2275-83 (Dec., 1960).
Studies were made of the climb of dislocations in silicon crystals ed by the diffusion of gold in the temperature range from to 1300°C. For some studies, dislocations were introduced reviously dislocation-free crystals by indentation at room erature and deformation at about 900°C in order to predeterboth the Burgers vector and the direction of deformation. It ossible in this way to introduce left-handed screw dislocations all concentrations. The left-handed screw dislocations were to form right-handed helices upon the diffusion of gold during quent heat treatment at temperatures above 1000°C. This rvation is shown to be consistent with the idea that gold diffuses interstitial atom and causes a vacancy deficiency in the neighood of dislocations. Further evidence of the structure sensiof the diffusion of gold is shown by autoradiographic techniques. es were made of the effect of heat-treatment times and quenching upon the diameter of helices. The diameter of the helices ases with time at a given temperature, and increases with erature during a given time of heat treatment. Variation of the ng time by a factor of 10^3 has no apparent effect on the diameter. efore, the helices form as a result of a gradient in the concenn of gold rather than by a quenching process. Impurities luced by heat treatment at 900°C strongly modify climb in als which are relatively free from oxygen. Precipitates believed formed during this heat treatment act as nucleation sites for the tion of prismatic loops. Crystals grown from quartz crucibles us containing about 10^{+5} atom fraction of oxygen have compliclimb mechanisms believed to be associated with the pinning of the oxygen on the dislocations. Modified Bardeen–Herring es have been found in these cases.

usion

91 DIFFUSION PROCESSES AT LOW TEMPERATURES.
A.B.Lidiard and K.Tharmalingam.
Faraday Soc. (GB), No. 28, 64-8 (1959).
Crystal imperfections" discussion (see Abstr. 2386 of 1961).
ng knowledge of defects in alkali and silver halide crystals d to predict the influence of impurity concentration and rature upon their anion diffusion properties. The free anionsy concentration is depressed by the presence of multivalent s in substitutional solution, especially at low temperatures. ations and vacancy pairs are therefore likely to be important n diffusion. The principles of the determination of anion on coefficients by exchange experiments are discussed. al features of this discussion apply to other ionic systems. ng experimental data on alkali and silver halides are sed.

92 DIFFUSION IN A FERROMAGNETIC ALLOY.
J.Stanley and C.Wert.
. Phys. (USA), Vol. 32, No. 2, 267-73 (Feb., 1961).
ffusion constants in an alloy of Fe+ 18% V were determined wide temperature range by a combination of radioactive and anelastic methods. The region of measurement extends considerable interval on both sides of the magnetic Curie rature. The data show a pronounced effect of ferromagnetic dering on diffusion. Diffusion in the well-ordered ferroic state is about 100 times slower than would be expected from extrapolation of data in the paramagnetic region. Part of this retardation appears to be an increase in the activation energy and, part a decrease in D .

2393 SELF-DIFFUSION OF ALPHA-IRON IN A LARGE TEMPERATURE GRADIENT. W.G.Brammer.
Acta metallurgica (Internat.), Vol. 8, No. 9, 630-6 (Sept., 1960).

Experimental results of an attempt to measure the thermal gradient self-diffusion in iron are given. A temperature gradient of 2500°C/cm was placed on each of three iron samples for 550 hr. Platinum wire markers were placed 0.01 in. apart, normal to the sample length; the marker spacings were measured before and after the diffusion anneal. No marker shift greater than the 0.0001 in. probable error was observed; whereas marker shifts of the order of 0.001 in. were anticipated from theoretical calculations. Each of several alternative possible conclusions which may be drawn from these results are discussed: (1) self-diffusion in α-iron is not via a vacancy mechanism, or (2) if the vacancy mechanism predominates in α-iron, then either (a) the activation energies for formation, E_f, and migration of vacancies, E_m, are nearly equal, or (b) the role of the barrier atoms must be explicitly considered in the process of thermal activation for an atom jump in a temperature gradient, in which case the mass flow is not proportional to the difference in E_f and E_m. The model of thermal gradient self-diffusion is discussed and several experiments are suggested. In addition, a calculation is given for the dependence of thermalgradient self-diffusion on the separation of vacancy sources and sinks, using parallel grain boundaries normal to the temperature gradient as the only sources and sinks which are important.

2394 DIFFUSION OF NICKEL IN SINGLE CRYSTALS OF COPPER. A.Ikushima.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1636 (Nov., 1959).

Radio tracer techniques were used to investigate the diffusion of Ni^{63} in Cu within the temperature range 695° - 1061°C. The diffusion coefficient D can be expressed as $D = D_0 \exp(-Q/RT)$, where $D_0 = 3.8 \pm 0.2$ cm²/sec and $Q = 56.8 \pm 0.1$ kcal/mole.

R.F.Peart

2395 DIFFUSION OF ZINC AND OXYGEN IN ZINC OXIDE.
W.J.Moore and E.L.Williams.
Disc. Faraday Soc. (GB), No. 28, 86-93 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). The diffusion of radioactive Zn^{65} in crystals of ZnO was measured by the method of thin sections, giving

$$D_{Zn} = 1.3 \times 10^{-5} \exp(-43.5 \pm 11.0 \text{ kcal/RT}) \text{ cm}^2 \text{ sec}^{-1}.$$

The diffusion of O^{18} in ZnO was computed from the exchange of O_2 with ZnO crystals, giving

$$D_O = 6.5 \times 10^{11} \exp(-165 \pm 6 \text{ kcal/RT}) \text{ cm}^2 \text{ sec}^{-1}.$$

The diffusion of Zn in ZnO is not controlled by defects associated with excess Zn, since it is of same order of magnitude in atmospheres of Zn and of O_2; a mechanism based on thermally produced Frenkel defects is suggested. The D_O depends on $P_{O_2}^{1/2}$ and a plausible mechanism to account for the extraordinarily high preexponential factor would be the diffusion of oxygen atoms along dislocation channels. The solubility of Zn from the vapour in spectroscopic-grade ZnO powder was measured as a function of T, and yields a heat of solution of $\Delta H^0 = 3.5$ kcal/mole.

2396 EFFECT OF PRESSURE ON THE MOBILITY OF INTERSTITIAL OXYGEN AND NITROGEN IN VANADIUM. G.W.Tichelaar, R.V.Coleman and D.Lazarus.
Phys. Rev. (USA), Vol. 121, No. 3, 748-52 (Feb. 1, 1961).

Measurements of stress relaxation as a function of hydrostatic pressure up to 9000 kg/cm² were made on a vanadium sample containing approximately 0.1 at.% dissolved oxygen and 0.2 at.% dissolved nitrogen. In the temperature range 83.0° to 98.0°C, the relaxation time due to dissolved oxygen is found to increase exponentially with pressure, the value at 9000 kg/cm² being about 1.7 times the value at 1 kg/cm². The pressure dependence of the stress relaxation can be interpreted in terms of an activation volume of 1.7 cm³/mole which is about equal to the molar volume of the diffusing oxygen atoms. The relaxation times due to the dissolved nitrogen were measured at 156.8° and 163.0°C. The values at 9000 kg/cm² are about 1.3 times the values at 1 kg/cm², the activation volume being about 1.1 cm³/mole.

Colour Centres

2397 SPECTRAL LOCATION OF ABSORPTION BANDS OF LATTICE DEFECT ELECTRONS IN ION GRIDS.
H.D.Koswig and O.Stasiw.
"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 119-30. In German.

The maxima of the absorption line of colour centres in alkali halides and various impurities in silver halides are deduced from an extension of Mollwo's F-centre formula; the lattice constant of the host crystal and the radius of the local defect determine the spectral position, without any connection with the macroscopic value of the host crystal's permittivity. A.Landman

Radiation Effects

2398 ANNEALING OF X-RAY INDUCED SURFACE HARDENING IN NaCl. R.Cuypers and S.Amelinckx.
Acta metallurgica (Internat), Vol. 8, No. 8, 551-3 (Aug., 1960).

Rocksalt crystals were irradiated with X-rays. The so-produced surface hardening and the resoftening due to annealing at different temperatures were followed. The activation energy of the process associated with the annealing in the temperature range 150°-300° C was derived. In agreement with experimental results obtained by other workers, the assumption that clusters of point defects are the principal cause of the surface hardening was found to be likely. For annealing temperatures below 300° C the resoftening would mainly result from the growth in size of these aggregates, and their corresponding decrease in number.

2399 AN X-RAY DIFFRACTION STUDY OF IRRADIATED MOLYBDENUM. D.L.Gray and W.V.Cummings, Jr.
Acta metallurgica (Internat.), Vol. 8, No. 7, 446-52 (July, 1960).

Changes in the lattice parameter, X-ray line width and microhardness of commercial molybdenum were observed after irradiation at $35 \pm 5^{\circ}$ C to various total fast neutron exposures from 6.5×10^{16} to 1.2×10^{20} nvt (neutrons/cm^2). The lattice parameter versus neutron exposure curve maximizes near 5.0×10^{19} nvt, and at 1.2×10^{20} nvt a net decrease from the pre-irradiation value occurs. Both line width and micro-hardness increase with neutron exposure and although the microhardness approaches a limiting value with increasing irradiation, the values of line width do not. These effects in irradiated molybdenum are discussed from the standpoint of some recovery reactions which may occur in reactor during irradiation and it is concluded that (1) interstitial atoms produced by neutron bombardment are mobile at the irradiation temperatures, 35° C, (2) during the initial stages of irradiation a substantial number of interstitials become trapped at small substitutional impurity atoms and (3) interstitial cluster formation and growth predominates during the remainder of the irradiation. Some mechanisms of interstitial cluster formation and growth are discussed.

2400 CHANGES IN ORGANIC CRYSTALS UNDER THE ACTION OF 60 kV ELECTRONS IN THE ELECTRON MICROSCOPE. L.Reimer.
Z.Naturforsch. (Germany), Vol. 15a, No. 5-6, 405-11 (May-June, 1960). In German.

Changes in crystallinity and in contrast following exposure to 60 kV electrons of low intensity (so minimizing heating effects) were studied in dark field and by electron diffraction. Paraffin wax, glycocoll, anthracene, indigo and phthalocyanine were investigated and it was considered that under normal conditions of microscopy, rapid losses in crystallinity would occur. Wide differences in the threshold value of specimen beam-dose were found. With glycocoll, the amorphous diffraction pattern was observed at 10^{-3} A sec. cm^2 compared with phthalocyanine which requires 3 A sec/cm^2.
R.Reed

EMISSION OF LIGHT ON DISSOLUTION OF IRRADIATED SOLIDS IN CERTAIN LIQUIDS. See Abstr. 1744

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

2401 INFLUENCE OF FERROMAGNETIC RESONANCE ON THE ELECTRICAL RESISTANCE OF METALS.
A.Bassompierre.
C.R.Acad. Sci. (France), Vol. 251, No. 20, 2141-3 (Nov. 14, 1960). In French.

Discusses the increase of resistance due to the scattering of the conduction electrons by spin waves created during the resonan process. E.P.Wohlfar

2402 ELECTRONIC CONDUCTION AND EXCHANGE INTER ACTION IN A NEW CLASS OF CONDUCTIVE ORGANI SOLIDS. R.G.Kepler, P.E.Bierstedt and R.E.Merrifield.
Phys. Rev. Letters (USA), Vol. 5, No. 11, 503-4 (Dec. 1, 1960).

Very high electrical conductivities are reported for a group o organic solids which are salts of the radical-ion formed by additio of an electron to tetracyanoquinodimethan. Absence of an activatio energy for conductivity and a temperature independent paramagnetism suggest a metal-like degenerate system in the quinolinium salt. A small activation energy exists in the triethylammonium sa and the electrical conductivity is highly anisotropic. In the potassium salt the activation energy is larger and the conductivity very small. Detailed studies of a wide range of these solids will be ma available. R.G.C.Arri

ELECTRIC RESISTANCE AND CATION DISTRIBUTION OF Fe–Mn FERRITE SYSTEM. See Abstr. 2484

Semiconductors

2403 SEMICONDUCTOR PROBLEMS. IV. [Halbleiter probleme. Band IV.]. Edited by W.Schottky.
Brunswick: Friedr. Vieweg (1958). vii + 381 pp. In German.

The book contains seven papers and extensive discussions (wi one exception). A detailed classification of subject matter relati to semiconductors is included. Summaries in English are given (with one exception). Abstracts of these papers will be found unde the appropriate chapter headings in this issue of Physics Abstrac

2404 THEORY OF TUNNELING.
E.O.Kane.
J. appl. Phys. (USA), Vol. 32, No. 1, 83-91 (Jan., 1961).

The theory of "direct" and "phonon-assisted" tunnelling is reviewed. Theoretical I–V characteristics are calculated using constant field model. Generalizations to nonconstant field and mo complicated band structure models are discussed briefly.

2405 THE MEASUREMENT OF THE LIFETIME OF MINORITY CARRIERS IN SEMICONDUCTORS.
W. de Kinder and J.Vennik.
C.R. Acad. Sci. (France), Vol. 251, No. 13, 1275-6 (Sept. 26, 1960). In French.

An adaptation of the method of Ramsa et al. (Abstr. 8111 of 19 which overcomes the difficulties due to the dependence of reflect on conductivity. Use is made of a microwave T-bridge. Results obtained for germanium agree with other methods. D.J.Oli

2406 DECAY OF EXCESS CARRIERS IN SEMICONDUCTORS.
K.C.Nomura and J.S.Blakemore.
Phys. Rev. (USA), Vol. 121, No. 3, 734-40 (Feb. 1, 1961).

For Pt I, see Abstr. 2320 of 1959. A physical interpretation given of the nonlinear differential equations which govern the deca of excess carrier populations through recombination centres. No restrictions are placed on the magnitudes of the excess carrier densities or the centre density. Criteria for trapping are presente with semiconductors for which the trapping level lies in the opposite half of the intrinsic gap from the Fermi level, it is show that trapping can be described as being of either a temporary or permanent nature. The variety of possible modes of decay are illustrated with the aid of numerical solutions and approximate analytic solutions.

ADSORPTION IN RELATION TO SEMICONDUCTIVITY AND OCIATED PROPERTIES OF SURFACES. See Abstr. 2549

MUONIUM FORMATION IN SEMICONDUCTORS. Abstr. 2074

miconducting Materials

407 EFFECT OF COPPER IMPURITY ATMOSPHERES AT DISLOCATIONS ON RECOMBINATION IN GERMANIUM.
Kalashnikov and A.K.Mednikov.
tverdogo Tela (USSR), Vol. 2, No. 9, 2058-65 (Sept., 1960).
ussian.
The formation of copper impurity atmospheres at edge dislocaɜ in germanium was found to reduce the effect of such dislocaɜ on recombination. Heat treatment removed impurity atmosɛs from dislocations and thus altered recombination; heat tment also affected recombination by formation of "thermal" ptors. [English translation in: Soviet Physics - Solid State)]. A.Tybulewicz

2408 MECHANISM OF RECOMBINATION-CENTRE FORMATION IN GERMANIUM AND SILICON QUENCHED FROM V TEMPERATURES. L.S.Milevskii.
tverdogo Tela (USSR), Vol. 2, No. 9, 2218-27 (Sept., 1960).
ussian.
Studies of the effect of quenching from 250-600°C on the ority-carrier lifetime in n-type germanium and silicon confirmed recombination centres were formed due to loss of "impurity ospheres" and subsequent motion of dislocations. Dislocations d be effectively immobilized by producing impurity atmospheres erately. In this way temperatures at which dislocations started ove could be raised, i.e. the fall of the minority-carrier lifetime d be displaced towards higher quenching temperatures.
ealing of recombination centres should be regarded as ersion of impurity atmospheres in some places and formation islocations) at other places. [English translation in: Soviet sics—Solid State (USA)]. A.Tybulewicz

409 VOLUME RECOMBINATION OF CARRIERS IN n-TYPE SILICON CONTAINING RADIATION DEFECTS.
Galkin, N.S.Rŷtova and V.S.Vavilov.
tverdogo Tele (USSR), Vol. 2, No. 9, 2025-30 (Sept., 1960).
ussian.
Describes studies of carrier capture by deep levels of radiation cts produced by bombardment with fast electrons. The position of ecombination level (E_C - 0.16 eV) was found and its capture cross-ons for electrons (10^{-15} cm^2) and holes (4×10^{-14} cm^2) were rmined. [English translation in: Soviet Physics - Solid State)]. A.Tybulewicz

2410 RECOMBINATION RADIATION FROM SILICON UNDER STRONG-FIELD CONDITIONS.
Davies and A.R.Storm, Jr.
. Rev. (USA), Vol. 121, No. 2, 381-7 (Jan. 15, 1961).
In an attempt to determine the distribution in energy of hot rons and holes in silicon placed in an intense uniform electric , measurements were made of the spectral distribution of re-ination radiation at 77°K (field strengths up to 3700 V cm^{-1}) t 20°K. No change in the spectrum with field was observed, than a rise in temperature of 6° at 77°K due to Joule heating 00 V cm^{-1} in the sample, from which it was concluded that re-ination radiation at these temperatures arises predominantly the decay of excitons formed from the hot carriers, and that xcitons have a thermal distribution of energy at the lattice erature. In addition, results are given for the spectrum of the tion from avalanche breakdown regions in reverse-biased n p—n junctions at 77° and 300°K; no differences were detected e range of energies 1.0-1.4 eV, from which it was concluded exciton decay does not contribute to the observed radiation at .

411 ON THE SCATTERING OF ELECTRONS IN InSb-n. Z.Kopeć.
Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), , No. 2, 111-14 (1960).
n explanation of the experimental values of the electron ity in InSb is given on the assumption that scattering by acous-honons is the dominant mechanism. Good agreement with experimental values is obtained provided a corrected value of the effective mass of the electron is used in the electron mobility formula. The corrected effective mass is computed from a non-quadratic dispersion formula. The treatment can also be extended to account for the concentration dependence of the electron mobility and also its dependence on temperature. D.A.Jones

2412 ON THE ANOMALOUS MAGNETORESISTANCE EFFECT IN N-InSb. W.Sasaki and C.Yamanouchi.
J. Phys. Soc. Japan, Vol. 14, No. 6, 849 (June, 1959).
Oscillatory magnetoresistance was studied at 4°K in samples with a carrier concentration between 10^{15} and 10^{16} cm^{-3}. If oscillatory magnetoresistance has the same origin as the de Haas–van Alphen effect, it will be observed only in samples for which the relaxation time is longer than the cyclotron period, and the Fermi energy is higher than the diamagnetic energy difference. In three of the samples investigated, the mobility was low, and these conditions could not be satisfied. None of these samples showed oscillatory magnetoresistance, whereas other samples did. It is concluded that oscillatory magnetoresistance and the de Haas—van Alphen effect are caused by the same mechanism. C.Hilsum

2413 EFFECT OF LANDAU LEVELS UPON TUNNEL CURRENTS IN INDIUM ANTIMONIDE.
A.G.Chynoweth, R.A.Logan and P.A.Wolff.
Phys. Rev. Letters (USA), Vol. 5, No. 12, 548-50 (Dec. 15, 1960).
It is known that when a magnetic field H is applied to an InSb Esaki diode the tunnel current is reduced. It is reported here that at low temperature one observes also oscillations of the tunnel current with 1/H, when H is parallel to the electric field. The oscillations are due to the oscillatory variation in the density of electrons available for tunnelling brought about by the Landau quantization in the conduction band of the n-type crystal. Values of the effective mass can be derived from the period of the oscillations. From the known band structure of InSb, the observed oscillations must be due to electron—heavy-hole tunnelling.
L.Pincherle

2414 ELECTRON EFFECTIVE MASSES OF InAs AND GaAs AS A FUNCTION OF TEMPERATURE AND DOPING.
M.Cardona.
Phys. Rev. (USA), Vol. 121, No. 3, 752-8 (Feb. 1, 1961).
The electron effective masses of several GaAs and InAs samples at room and liquid nitrogen temperatures were determined from Faraday rotation and infrared reflectiviey measurements. An increase in effective mass with increasing carrier concentration was found in both materials. This increase can be quantitatively interpreted in InAs in terms of the nonparabolic nature of the conduction band. In GaAs the increase in effective mass with doping suggests the existence of another set of conduction band minima above the lowest (000) minimum. The measured temperature variation of the effective mass can be attributed to two mechanisms: the increase in effective mass produced by the spread in the Fermi distribution because of the nonparabolic shape of the band, and the variation in the band structure produced by the thermal expansion of the lattice. The Faraday rotation due to the interband transitions was measured in GaAs and InAs. This rotation is clockwise along the direction of motion of the radiation and the magnetic field for GaAs and counter-clockwise for InAs. This effect is compared with the corresponding effect in other semiconductors.

2415 ELECTRICAL PROPERTIES OF In_2Te_3 WHICH IS A SEMICONDUCTOR WITH IMPERFECT STRUCTURE.
V.P.Zhuze, V.M.Sergeeva and A.I.Shelŷkh.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2858-71 (Nov., 1960).
In Russian.
Reports measurements of the electrical conductivity, thermoelectric power and the Hall effect of In_2Te_3 which contains a large number of cation vacancies. Carrier mobilities in In_2Te_3 were low because of the scattering of the carriers on vacancies. In a wide range of temperatures, the mobilities are independent of temperature, confirming the dominant role of scattering on neutral cation vacancies. The forbidden energy gap and effective carrier masses were measured; chemical binding is discussed. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

SEMICONDUCTING PROPERTIES OF MAGNETITE. See Abstr. 2476

THE HALL EFFECT IN VANADIUM SILICIDES. See Abstr. 2449

2416 PHYSICAL PROPERTIES OF SEVERAL II–V SEMICONDUCTORS.

W.J.Turner, A.S.Fischler and W.E.Reese.

Phys. Rev. (USA), Vol. 121, No. 3, 759-67 (Feb. 1, 1961).

The physical properties of single crystals of the noncubic II–V semiconducting compounds Zn_3As_2, $ZnAs_2$, ZnSb, Cd_3As_2, $CdAs_2$, and CdSb were investigated. Energy gaps in the these materials vary from approximately 0.13 to 1.0 eV. Mobilities at 297°K range from 10 cm^2/V sec to 15 000 cm^2/V sec and increase at low temperature. Resistivity and mobility anisotropy were investigated in detail for $CdAs_2$. Except for the $A_3^{II}B_2^{V}$ compounds, high optical transmission was observed from the intrinsic edge to approximately 30 μ.

Semiconductor Devices

2417 PRESENT POSITION OF DEVELOPMENT AND APPLICATION OF TRANSISTORS. J.Dosse.

"Semiconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 190-221. In German.

This is a technological survey of the achievements in performance and application, with a large number of illustrations.

A.Landman

2418 UNIFORM AVALANCHE EFFECT IN SILICON THREE-LAYER DIODES. A.Goetzberger.

J. appl. Phys (USA), Vol. 31, No. 12, 2260-1 (Dec., 1960).

Interaction of current gain and avalanche multiplication in three-layer diodes is utilized to produce uniform avalanche effect, indicated by uniform light emission over the area of a junction. Proof that the effect is caused by the three-layer action is furnished by removing the emitter layer, which changes the light emission to the usually observed microplasma pattern.

SURFACE-BARRIER SEMICONDUCTOR PARTICLE DETECTORS. See Abstr. 1992

SURFACE MEASUREMENTS ON FRESHLY CLEAVED SILICON p–n JUNCTIONS. See Abstr. 1362

Photoconductivity

2419 THE PHOTOCONDUCTIVITY OF MOLECULAR CRYSTALS. J.N.Murrell.

Disc. Faraday Soc. (GB), No. 28, 36-47 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Theoretical expressions are derived for the photocurrent of a molecular crystal in the form of a power series in the light intensity, which includes the first- and second-order terms. The current depends in the first instance on the relative values of the potential difference across the crystal, the extinction coefficient of the crystal, and the rate at which free carriers are trapped. It is shown that the experimental results can only be understood if one assumes that the trapping of charge carriers is more important in limiting the carrier concentration than the discharge of the carriers at the electrodes. From the sign of the rectifying effect it is deduced that the positive carriers are the more mobile.

2420 FIELD-EFFECT MODULATION OF PHOTOCONDUCTANCE IN A QUASI-INTRINSIC SEMICONDUCTOR.

R.R.Bockemuehl.

J. appl. Phys. (USA), Vol. 31, No. 12, 2255-9 (Dec., 1960).

The field-effect modulation of conductance in a dark-insulating photoconductor is strongly dependent on the properties of carriers of both signs. An analysis of the equilibrium space charge density resulting from electron-hole pair generation in a "depletion layer" and the resulting influence on the terminal characteristics of a photoconductive field-effect transistor is presented. The derived relationships explain the optical and frequency response behaviour of CdS field-effect modulation of photoconductance to be observed, and provide a method for evaluating the drift mobility of holes and other carrier properties in a quasi-intrinsic semiconductor.

2421 EFFECT OF PHOTOEXCITATION ON THE MOBILITY IN PHOTOCONDUCTING INSULATORS.

R.H.Bube and H.E.MacDonald.

Phys. Rev. (USA), Vol. 121, No. 2, 473-83 (Jan. 15, 1961).

The Hall mobility of carriers in photoconducting insulators can be varied over an appreciable range by the effects of photoexcitation. Such a variation can result either (1) from a change in the density of scattering centres as the result of a change in the occupation of imperfection centres, or (2) from the initiation of two-carrier conductivity. Suitable use of the phenomena involved in the photo-Hall effect can lead not only to knowledge about carrier density, carrier sign, and carrier mobility, but also about the charge on imperfection centres, and to an independent determination of the cross-section of imperfection centres. Experiments on CdS and CdSe single crystals with conductivities lying between 10^{-9} and 10^{-} mho/cm are described to illustrate the potentialities of the technique. The results emphasize both the importance that changes in mobility can play in normal photoconductive processes, and the importance of hole conductivity under suitable circumstances.

2422 TRAPPING CENTRES IN ANTHRACENE CRYSTALS. F.J.Bryant, A.Bree, P.E.Fielding and W.G.Schneider.

Disc. Faraday Soc. (GB), No. 28, 48-53 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Discrete trapping centres in anthracene single crystals have been established by the conductivity glow-curve method. Evidence is presented for the existence of three separate levels having trap depths of approximately 0.6, 0.7 and 0.8 eV. The centres at 0.8 eV give rise to the most prominent peak in the glow-curve. Doping with tetracene eliminates this peak leaving a small but broad peak due to trapping centres in the region of 0.7 eV. Irradiation of the crystals with X-rays also causes the main glow peak to disappear.

2423 PHOTO-E.M.F.'S IN ANTHRACENE. I. Yu.I.Plotnikov and Zh.I.Matalygina.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2517-25 (Oct., 1960). In Russian.

Photo-e.m.f.'s were produced by illumination with modulated light of λ = 3650 A (in the fundamental absorption region of anthracene) and with non-monochromatic light of wavelengths greater than 3100 A. The dependence of these photo-e.m.f.'s on the intensity and duration of illumination and on temperature is studied. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

2424 GENERATION OF FREE CARRIERS IN PHOTOCONDUCTING ANTHRACENE. I.

W.Moore and M.Silver.

J. chem. Phys. (USA), Vol. 33, No. 6, 1671-6 (Dec., 1960).

The source of free carriers in photoconducting anthracene was determined from an investigation of the spatial distribution of trapped electrons. Free carriers are generated in the bulk in addition to electrons being injected into the anthracene at the negative electrode. The bulk generated carriers cannot come from an intrinsic process which simultaneously yields a free electron and a free hole. A tentative extrinsic model for the generation of free carriers is proposed in which electrons are injected at the negative electrode, free holes and trapped electrons are generated by the incident radiation in the bulk at impurities or other defects, and free holes are generated by the incident radiation at the positive illuminated electrode. On the basis of these results, one concludes that anthracene is an extrinsic rather than an intrinsic photoconductor.

PHOTOCONDUCTION OF CdS. See Abstr. 2436

2425 PHOTOCONDUCTIVE TIME CONSTANTS AND RELATED CHARACTERISTICS OF p-TYPE GOLD-DOPED GERMANIUM.

T.P.Vogl, J.R.Hansen and M.Garbuny.

J. Opt. Soc. Amer., Vol. 51, No. 1, 70-5 (Jan., 1961).

To measure these very short time constants, two alternative methods were applied and compared. The first is indirect, using the relationship between the magnitude of generation-recombination noise and carrier lifeftimes. The second method is direct, employing a high-speed light-pulsing technique. If no other noise sources are important, the results of the indirect method approach those of the direct method as a lower limit. A combination of such time-constant measurements was performed on a series of crystals in

h impurity densities and carrier concentrations had been
ated by Hall coefficient and conductivity measurements. From
e data quantum yields of carrier generation, and cross-sections
hoton capture and carrier recombination were evaluated. The
on capture cross-section of the 0.15 eV gold acceptor level at
s 1.3×10^{-16} cm^2, averaging 0.9×10^{-16} cm^2 for 2-9 μ. The
capture cross-section by the Au^- ion in germanium was found
2.3×10^{-14} cm^2.

2426 THE MECHANISM OF NEGATIVE PHOTOCONDUCTIVITY. G.A.Zholkevich.
tverdogo Tela (USSR), Vol. 2, No. 10, 2480-3 (Oct., 1960).
ıssian.
Negative photoconductivity (increase of resistivity on
ination) of polycrystalline ZnSe layers was found to be due to an
ease of the intercrystallite barrier potentials on the recombina-
of photoelectrons with surface states. [English translation in:
et Physics—Solid State (USA)]. A.Tybulewicz

ermoelectric Properties

2427 THE TECHNICAL EXPLOITATION OF THE THERMAL ENERGY OF METALS AND SEMICONDUCTORS.
utz.
niconductor Problems", Vol. 4 (Abstr. 2403 of 1961) p. 145-87.
erman.
Present knowledge of thermoelectric effects is reviewed in de-
The effective thermoelectric power, which decreases with
ving Wiedemann—Franz—Lorenz ratio, is highest in semicon-
ors of high carrier-density, and methods are suggested of
ner increasing same by doping and alloying techniques. Engin-
ng applications of the Peltier effect for heating and cooling
oses are discussed, also the problems of efficient thermoelec-
power generation, i.e. the utilization of the Seebeck effect; an
ctive application is the solar thermoelectric generator.
references. A.Landman

2428 LOCALIZED ELECTRON MODEL AND THERMOELECTRIC POWER. M.Tsuji.
ys. Soc. Japan, Vol. 14, No. 11, 1640 (Nov., 1959).
A formula is derived for the thermoelectric power of a crystal
nich the carriers are tightly bound and need an activation
gy to jump from one ion to another. It is shown that Morin's
sis of measurements on α-Fe_2O_3 and NiO is not consistent.
D.J.Huntley

2429 THE SOLUTION OF THE NON-STATIONARY THERMAL CONDUCTIVITY PROBLEM FOR A ROD, ON THE ENDS WHICH ARE ATTACHED MASSES. CALCULATION FOR A FERENTIAL THERMO-BATTERY. V.P.Vlasov and S.A.Markin.
ekh. Fiz. (USSR), Vol. 30, No. 9, 1128-33 (Sept., 1960). In
ian.
The calculation is applied to the variation of e.m.f. with time of
rmo-battery, the alternate junctions of which have different
nal inertia, after it has been placed in a medium differing in
erature from the surroundings in which it had all come to a
ant temperature. There is satisfactory agreement with
riment. [English translation in: Soviet Physics—Technical
ics (USA), Vol. 5, No. 9, 1062-8 (March, 1961)]. R.Berman

lectric Properties

2430 PROPERTIES OF ALKALI HALIDE CRYSTALS. DIELECTRIC LOSSES IN KCl:Ba CRYSTALS.
oitsekhovskaya, L.G.Golubeva and E.V.Tyutyunnikova.
tverdogo Tela (USSR), Vol. 2, No. 10, 2536-9 (Oct., 1960). In
ian.
Measurements of tan δ at 300-1500 c/s between -55^0 and $+60^0$ C
ed that the dielectric losses were of the relaxation type through-
most the whole range of frequencies. The frequency dependence
h δ had three maxima. One of them is due to oscillation of di-
formed by the association of Ba^{2+} ions with cation vacancies.
econd is due to oscillations of the same dipole when impurity
orm a secondary lattice within the KCl lattice. The origin
third maximum is not clear. [English translation in: Soviet
cs—Solid State (USA)]. A.Tybulewicz

2431 ON THE MOLECULAR NATURE OF THE DIELECTRIC ANOMALIES IN THIOUREA. C.Calvo.
J. chem. Phys. (USA), Vol. 33, No. 6, 1721-31 (Dec., 1960).
Of the four dielectric anomalies in thiourea, three are shown to be correlated with the disordering of the molecules in the crystal. This disordering involves both a relative rotation and a translation of the molecules between potential minima. One of the other anomalies, the high one in temperature, is shown to result from a translation of the molecules within the unit cell. Lattice parameter measurements as a function of temperature confirm that the lowest transition is of first order and show only a change in slope at the highest transition. An electrostatic model based upon the electronic resonance structures of thiourea is used to discuss the binding energy of the molecules in the crystal, the vibration of the molecules, the equilibrium orientation of the molecules in the unit cell, and the spontaneous polarization of the crystal. A simple statistical model based upon two interpenetrating non-identical sublattices reveals a disordering of the molecules from 0^0K to 178^0K and yields the first-order transition together with the two ferrielectric regions of temperature.

2432 THE FREQUENCY AND TEMPERATURE DEPENDENCES OF ϵ AND TAN δ OF $ZnPtTiO_2$ POLYCRYSTALS. A.A.Kuznetsov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1088-94 (Sept., 1960).
In Russian.
These dependences are discussed for various compositions of the polycrystals and the presence is shown of electronic, ionic and relaxation polarization. Dielectric losses are ascribed to the motion of weakly bound ions (relaxation and conduction). The activation energies of ions participating in conduction and relaxation processes are estimated. [English translation in: Soviet Physics—Technical Physics (USA), Vol. 5, No. 9, 1018-24 (March, 1961)].
A.Tybulewicz

2433 SOME FEATURES OF THE PIEZOELECTRIC EFFECT IN BARIUM TITANATE. Z.A.Shamro.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2085-8 (Sept., 1960). In Russian.
Data are given for the piezo-modulus of polycrystalline barium titanate specimens as a function of the temperature and field existing during the polarization process. The most effective polarization was obtained 5-10^0 C below the Curie temperature. The effect of temperature on the piezo-modulus of certain of the specimens is also investigated. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

2434 THE NEGATIVE PHOTODIELECTRIC EFFECT. Ya.A.Oksman and A.V.Burlakov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 1, 77-80 (Sept. 1, 1960). In Russian.
The kinetic photodielectric effect was observed in CdSe with a time resolution better than 10^{-3} sec. The negative effect, in which the conductivity decreases on illumination, was examined by measuring the changes in the real and imaginary components of the conductivity on illumination. The results are considered to be evidence for the existence of relaxation polarization of shallow, localized levels trapping current carriers. [English translation in: Soviet Physics—Doklady (USA)]. K.N.R.Taylor

2435 THE INFLUENCE OF IONIC CONDUCTIVITY ON THE ELECTRIC STRENGTH OF KCl AND NaCl.
R.Cooper, R.M.Higgin and W.A.Smith.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 817-25 (Dec. 1, 1960).
At high temperatures, the electric strengths of the alkali halides appear to decrease rapidly with rise in temperature. This behaviour is qualitatively similar to that predicted by Fröhlich's high-temperature theory of breakdown. It can also be explained in terms of space charge and thermal effects due to the transport of ions and therefore speculation exists about the operative mechanisms. The ionic conductivity of alkali halide crystals depends upon the amount of bivalent impurity they contain. This fact was used to determine the infuence of ionic conductivity upon the electric breakdown of KCl and NaCl. No evidence was found to support Fröhlich's high-temperature theory, the observed negative temperature coefficient of KCl being attributed to ionic phenomena, Changes of up to sixty-fold in the ionic conductivity of NaCl did not influence the impulse electric strength of this material except at temperatures below about -50^0 C, when the effect of increased conductivity was to increase the electric strength.

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

2436 OPTICAL PROPERTIES AND PHOTOCONDUCTION OF CdS. K.W.Böer.

"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1951) p. 32-50.

General review paper which includes some photomicrographs of CdS crystals under the influence of monochromatic light and electric fields. C.A.Hogarth

2437 OPTICAL PROPERTIES OF CdS MONOCRYSTALS. M.S.Brodin.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2152-7 (Sept., 1960). In Russian.

The dispersion and reflectivity of CdS monocrystals were measured at 290° and 20°K: the dispersion curves in the region where the crystals were transparent or began to absorb; the reflectivity curves in the absorption region up to 2800 A. The dispersion curves and the dichroism of absorption were analysed: it was found that in the absorption region the Kramers–Kronig dispersion formula was obeyed. Variation of the reflectivity curves from sample to sample was noted. [English translation in: Soviet Physics – Solid State (USA)]. A.Tybulewicz

2438 OPTICAL PROPERTIES OF SAPPHIRE IN THE FAR INFRARED. E.V.Loewenstein.

J. Opt. Soc. Amer., Vol. 51, No. 1, 108-112 (Jan., 1961).

Investigations were undertaken of artifical sapphire utilizing the channel spectrum. The instrument used is a large interferometer designed for application in the far infrared. The interferograms and spectra show that sapphire is birefringent in the far infrared, with n_{ord}=3.14±4% and n_{ext}=3.61±4%, in the region 20 to 60 cm^{-1}. Sapphire is found to be highly transparent from 10 to 40 cm^{-1}, with the transmission dropping to zero near 90 cm^{-1}.

2439 OPTICAL PROPERTIES AND BAND MODEL OF SELENIUM. A.Gobrecht and A.Tausend.

Z. Phys. (Germany), Vol. 161, No. 2, 205-20 (1961). In German.

The optical properties of Se in the amorphous and in the single crystalline state were investigated in the range from 0.4 to 23 μ. Among other quantities, the paper gives the dependence of the absorption coefficient and the refractive index on the angle between the electric field vector and the main crystallographic axis. A qualitative interpretation of the experimental results is given in terms of a band model. P.T.Landsberg

REFLECTIVITY OF GOLD-TIN ALLOYS. See Abstr. 1455

2440 OPTICAL ABSORPTION DUE TO THE INTRODUCTION OF CARBON INTO THE SILICON LATTICE.

M.Balkanski, W.Nazarewicz and É.da Silva.

C.R. Acad. Sci. (France), Vol. 251, No. 13, 1277-9 (Sept. 26, 1960). In French.

Silicon doped with carbon shows an absorption band near 12.2 μ. The strength of the absorption depends on the carbon concentration, but is independent of temperature over the range 20° to 500°K. The band coincides in wavelength with the Restrahlen band of silicon carbide. C.Hilsum

2441 OPTICAL ABSORPTION OF CUPROUS OXIDE. P.W.Baumeister.

Phys. Rev. (USA), Vol. 121, No. 2, 359-62 (Jan. 15, 1961).

The relative optical absorption coefficient α of polycrystalline slabs of cuprous oxide was measured at 295°, 77°, and 4.2°K. At 4.2°K, α is proportional to $[\sigma - E_0]^{1/2}$ for 16 510 $cm^{-1} \leq \sigma \leq$ 16 900 cm^{-1}, where σ is the wave number. At 77°K an additional component appears, so that $\alpha = \alpha_1 + \alpha_2$, with $\alpha_1 \propto [\sigma - E_1]^{1/2}$ and $\alpha_2 \propto [\sigma - E_2]^{1/2}$. This is attributed to indirect transitions to exciton levels, in agreement with a theory by Elliott (Abstr. 4952 of 1957). The ratio of the integrated absorption coefficient of the first two exciton lines, after corrections for the background were applied, is also in satisfactory agreement with Elliott's theory.

2442 SPECTRUM OF Yb^{3+} IN YTTRIUM GALLIUM GARNET. R.Pappalardo and D.L.Wood.

J. chem. Phys. (USA), Vol. 33, No. 6, 1734-42 (Dec., 1960).

The optical absorption at various temperatures of an ytterbium doped yttrium gallium garnet is reported. The effect of a cubic and rhombic crystal field on the splitting of the free-ion levels is calculated. A tentative interpretation of the fine details of the spectrum is given.

2443 ABSORPTION SPECTRUM AND ZEEMAN EFFECT OF SAMARIUM MAGNESIUM NITRATE.

A.Friederich, K.H.Hellwege and H.Lämmermann.

Z. Phys. (Germany), Vol. 159, No. 5, 524-32 (1960). In German.

The spectra of five line groups in the visible region were photographed at 4.2°K with single crystals, showing the polarization and Zeeman patterns. A term scheme was given, together with the crystal quantum numbers, μ, ν, the angular momentum quantum number J, and the g-factors. The magnetic specific heat was calculated from the parameters of the ground term, $^6H_{5/2}$. G.F.Lothian

2444 THE STRUCTURE OF THE VIBRATIONAL SPECTRUM OF THE HYDROGEN BOND IN CERTAIN CRYSTALS.

A.I.Stekhanov and A.A.Klochikhin.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2932-7 (Nov., 1960). In Russian.

Lines have been observed at 3263, 3322, 3396, 3453 and 3559 cm^{-1} in both the Raman and infrared absorption spectra of $NaH_2PO_4.2H_2O$ crystals, and are attributed to OH groups involved in a weak hydrogen bond. The first four lines are two doublets similar to that at 3405-3495 cm^{-1} in the Raman spectrum of gypsum (Abstr. 5792 of 1956), suggesting that the bond provides two equilibrium positions for the proton. A simple calculation for a potential energy with two symmetrical minima gives the correct order of magnitude for the term splitting. [English translation in: Soviet Physics–Solid State (USA)]. I.D.C.Gurney

2445 INFRARED SPECTRA OF CRYSTALLINE CD_3Cl AND CD_3Br. D.A.Dows.

J. chem. Phys. (USA), Vol. 33, No. 6, 1743-5 (Dec., 1960).

Infrared spectra were obtained for deuterated methyl chloride and bromide. The region covered includes all fundamental vibrations, many of which showed splittings similar to those observed for the normal methyl halides (Abstr. 8692 of 1958). Assignments are presented, and librational frequencies in the methyl halides are summarized.

2446 THE INFRARED ABSORPTION AND THE ENERGY-BAND STRUCTURE OF CUPROUS OXIDE.

M.P.Lisitsa and G.A.Kholodar'.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2117-25 (Sept., 1960). In Russian.

Describes a study of the infrared (0.6-24 μ) transmission of polycrystalline Cu_2O samples of various thicknesses. A background due to excess oxygen, was detected beyond the fundamental absorption edge. Several new absorption maxima were found; their origin is not clear. The effect of temperature on individual bands was studied and a polaron absorption band was detected at 17.6μ. The 12.6 μ band is of electronic origin. The presence of bands due to absorption by free holes confirmed the complex structure of the Cu_2O valence energy band. [English translation in: Soviet Physics – Solid State (USA)]. A.Tybulewicz

2447 INFRARED ABSORPTION SPECTRUM OF $NdCl_3$. F.Varsanyi and G.H.Dieke.

J. chem. Phys. (USA), Vol. 33, No. 6, 1616-18 (Dec., 1960).

The infrared absorption spectrum of $NdCl_3$ was obtained under high resolution which showed the transitions from the ground state to $^4I_{13/2}$ and $^4I_{15/2}$ the latter of which was hitherto unknown. The crystals were 5% and 50% $NdCl_3$ in $LaCl_3$ and the higher Nd concentration shows a decided frequency shift of the lines.

2448 ELECTRONIC STATES OF HYDRATED VANADIUM (II) ION. R.M.Bennett and O.G.Holmes.

Canad. J. Chem., Vol. 38, No. 12, 2319-23 (Dec., 1960).

The optical absorption of a single crystal of $VSO_4.7H_2O$ was measured in the range 9000-35 000 cm^{-1}. The three observed bands were assigned to transitions between the four orbital levels resulting from cubic electrostatic perturbation of the spherical terms of con-

ration $3d^3$. Values of Dq = 1200 cm^{-1} and E = 10 000 cm^{-1} were ved from the spectral analysis.

2449 FINE STRUCTURE IN THE X-RAY ABSORPTION K-SPECTRA AND THE HALL EFFECT IN THE ICIDES OF VANADIUM.
.Vainshtein, E.A.Zhurakovskii, V.S.Neshpor and G.V.Samsonov.
l. Akad. Nauk SSSR, Vol. 134, No. 1, 68-70 (Sept. 1, 1960).
ussian.
The X-ray absorption K-spectra of vanadium and its silicides, i, V_5Si_3, VSi_2, were examined and compared with the spectrum of e. The Hall constant was also found and used with published ductivity data to evaluate the conductivity parameters. The ition of the absorption edge was found to increase regularly in rgy with decrease of the percentage of vanadium. [English nslation in: Soviet Physics—Doklady (USA)]. K.N.R.Taylor

minescence

2450 EIGHTH ALL-UNION CONFERENCE ON LUMINESCENCE.
.Borisevich, M.A.El'yashevich and B.I.Stepanov.
ekhi fiz. Nauk (USSR), Vol. 71, No. 1, 131-6 (May, 1960). In sian. English translation in: Soviet Physics—Uspekhi (USA), 3, No. 3, 417-22 (Nov.-Dec., 1960).
Held in Minsk, on 19-24 October, 1959. Over 100 papers were sented on molecular luminescence and luminescence analysis. y papers were published in Izv. Akad. Nauk SSSR, Ser. fiz., 24, No. 5-6 (May-June, 1960).

2451 THE INVESTIGATION OF AN ORGANIC PHOSPHOR IN THE PRE-EXCITED STATE. M.Frackowiak.
tics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of) p. 76-81. In German.
The fluorescence and phosphorescence as well as the optical rption characteristics of acridine yellow in gelatine depend on conditions, particularly the time, obtaining before excitation, lving unstable deformed molecules. The luminescence transi- probability and degree of polarization are also affected by pre- tation conditions. G.F.J.Garlick

2452 ELECTRON–VIBRATIONAL PROCESSES IN LUMINESCENCE CENTRES OF IONIC CRYSTALS.
3.Lushchik, N.E.Lushchik and K.K.Shvarts.
ka i Spektrosk. (USSR), Vol. 9, No. 2, 215-22 (Aug., 1960).
ussian.
Reports a study of the luminescence and absorption spectra and e luminescence quantum yield of alkali-halide crystals as a ion of the exciting-light frequency, f_e, and temperature. It was d that radiative and radiationless transitions occurred in lumin- nce centres after equilibrium was reached between the stored national energy distribution in a crystal and the same distribution cited centres. The quantum yield depended step-wise on f_e. lish translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 17 (Aug., 1960)]. A.Tybulewicz

2453 A RELATIONSHIP BETWEEN ELECTRON–VIBRATIONAL ABSORPTION AND LUMINESCENCE
08. K.K.Rebane and O.I.Sil'd.
a i Spektrosk. (USSR), Vol. 9, No. 4, 521-3 (Oct., 1960).
ssian.
Levshin (1951) gave a mirror-symmetry law for absorption and escent bands. The present note establishes a relationship ar to that of Levshin for a luminescence centre in a crystal or ecule, when vibrational frequencies are affected by electronic itions. [English translation in: Optics and Spectrosc. (USA) , No. 4, 272-3 (Oct., 1960)]. A.Tybulewicz

ENSITIZED FLUORESCENCE OF MOLECULAR CRYSTALS.
bstr. 1771

2454 LUMINESCENCE CENTRES IN COPPER BROMIDE.
P.Shvist.
phys. Hungar., Vol. 12, No. 1, 93-4 (1960). In Russian.
eports that argon (containing $< 0.02\%$ O_2) and pure hydro- ntensify the low-temperature luminescence of CuBr in the way as does air or oxygen. Suggests that all these gases ize surface centres containing Br. A.Tybulewicz

2455 THE LUMINESCENCE OF URANIUM-ACTIVATED FLUORIDES. J.E.A.Lys and W.A.Runciman.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 158-60 (July, 1960).
The following uranium-activated fluorides show fairly sharp line luminescence spectra at 77°K: LiF, NaF, KF, MgF_2, ZnF_2 (weak). The following show a band structure not resolved into lines: CsF, CaF_2, SrF_2, BaF_2 (weak). CdF_2 has a weak continuous spectrum, and CeF_3 and AlF_3 show no luminescence. The spectrum of MgF_2:U shows an easily recognizable pattern (strong green in colour at 77°K, weak at room temperature) with a repetition frequency of 804 cm^{-1}, probably corresponding to the normal vibrational mode of a (UO_4F_2) luminescent centre. The absorption is also a line spectrum but with no recognizable pattern. The absorption spectra of NaF:U and LiF:U were also examined. J.B.Birks

2456 A NEW PHOSPHOR $2Li_2O.WO_3$:U.
Yu.S.Leonov.
Optika i Spektrosk. (USSR), Vol. 9, No. 2, 275-6 (Aug., 1960).
In Russian.
The new phosphor was prepared by heating a mixture of Li_2CO_3 and WO_3 (taken in proportions of 2:1) for two hours at 640°C and one hour at 1090°C. The optimum amount of uranium was about 1.3 mol.%. Luminescence spectrum of the new phosphor, excited with 365 mμ light, was an asymmetrical sharp band with a main peak at 520 mμ and a subsidiary one at 530 mμ. The intensity of luminescence excited with 365 mμ light was equal to that of ZnS:Cu under the same conditions; when excited with 253.7 mμ light the intensity was comparable with that of Zn_2SiO_4:Mn. The intensity was highest when the phosphor had the exact stoichiometric composition given by $2Li_2O.WO_3$. The phosphor stored light energy when excited with 253.7 mμ light or with electrons. X-ray and thermal analyses showed that the phosphor consisted of one phase only. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 145 (Aug., 1960)]. A.Tybulewicz

2457 LUMINESCENCE AND ITS KINETICS DURING EXCITATION OF ZnS : Mn PHOSPHORS.
V.L.Levshin and V.F.Tunitskaya.
Optika i Spektrosk.(USSR), Vol. 9, No. 2, 223-32 (Aug., 1960).
In Russian.
Reports a study of the effect of temperature on the absorption spectra and on the blue and orange luminescence of ZnS : Mn. Luminescence and quenching processes are discussed and an energy diagram is proposed for the localization levels of electrons and holes. [English translation in: Optics and Spectrosc. (USA), Vol. 9, No. 2, 118-23 (Aug., 1960)]. A.Tybulewicz

2458 INSTRUMENT TO MEASURE FLUORESCENCE LIFETIMES IN THE MILLIMICROSECOND REGION.
R.G.Bennett.
Rev. sci. Instrum (USA), Vol. 31, No. 12, 1275-9 (Dec., 1960).
Fluorescence excited by a hydrogen flash lamp is observed stroboscopically with a gated photomultiplier. The method of gating is novel and achieves a time resolution comparable with fast oscilloscopes (1.8×10^{-9} sec). The data are presented in the form of a chart record.

2459 THE SCINTILLATION PROCESS IN ORGANIC SYSTEMS.
J.B.Birks.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 2-11 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960].
The scintillation process in organic crystals and solutions is described, and a mechanism is proposed to account for the origin of the fast and slow scintillation components. The intermolecular energy migration and transfer processes in pure and mixed crystals and in plastic and liquid solutions are discussed quantitatively, and the influence of temperature and thickness on the scintillation and fluorescence properties is considered. Radiative processes are shown to be important in crystals and in solid solutions. 49 references.

2460 THE ORIGIN OF SCINTILLATIONS IN ORGANIC MATERIALS. W.L.Buck.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 11-16 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Syposium, Washington, February 1, 1960].
Calculations of the energy expended by a charged particle in producing aptical excitation of molecules of the scintillator indicate

the possibility that most of the energy emitted as light during a scintillation may stem, either directly or via intermolecular transfer, from molecules excited in this way. Observations of the slowly decaying components of the emission suggest, however, that these components arise from molecules lift in excited states as a result of the process of ion recombination.

2461 SCINTILLATION RESPONSE OF ACTIVATED IONIC CRYSTALS TO CHARGED PARTICLES.
A.Meyer and R.B.Murray.
IRE Trans nuclear Sci. (USA), Vol. NS-7, No. 2-3, 22-5 (June-Sept., 1960). [Proceedings of the Seventh Scintillation Counter Symposium, Washington, February, 1960]

Experimental studies of the response of thallium activated alkali iodides to various charged particles indicate decreasing scintillation efficiency with increasing particle mass and a non-linearity in pulse height versus energy for heavier particles. The scintillation efficiency to electrons, however, is found to be anomalously low, less than that to protons and deuterons. An attempt is made to synthesize the results of various experiments and to provide a model for understanding the observed behaviour. The model adopted treats the formation of energy carriers and the transport of energy by the diffusion of these carriers from the path of the incoming particle to the activator sites. Results of calculations based on this model are found to be generally consistent with experiment.

2462 LUMINESCENCE OF PLASTIC SCINTILLATORS.
I.M.Rozman and S.F.Kilin.
Uspekhi fiz. Nauk (USSR), Vol. 69, No. 3, 459-82 (Nov., 1959).
In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 6, 856-73 (June, 1960).

A review with 117 references, with sections on preparative methods; on the glow spectra, and the efficiency and kinetics of scintillations; on the excitation and ionization processes, the absolute luminescence yield, and the energy transfer mechanism; and on practical applications. A number of diagrams and tables of data are included. S.T.Henderson

2463 A PARALLEL STUDY OF DEPOLARIZATION AND ELECTROLUMINESCENCE OF ZnS PHOTOELECTRETS.
V.M.Fridkin, A.N.Bogatyrev and É.V.Brakhman.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2185-90 (Sept., 1960).
In Russian.

Alternating fields depolarized ZnS:Cu photoelectrets and produced electroluminescence; electroluminescence caused further depolarization. The results are interpreted in terms of a scheme of two types of local level: shallow and deep ones, responsible for dark and photopolarization, respectively. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

MAGNETIC PROPERTIES OF SOLIDS

2464 MAGNETIC PROPERTIES OF $KMnF_3$. I. CRYSTALLOGRAPHIC STUDIES. O.Beckman and K.Knox.
Phys. Rev. (USA), Vol. 121, No. 2, 376-80 (Jan. 15, 1961).

The lattice parameters were determined by means of an X-ray rotation camera designed for temperatures down to 15°K. The cubic room temperature perovskite structure transforms at 184°K to an orthohombic phase with D_{2h}^{16}- Pbnm as the most probable space group with a unit cell containing 4 formula units; it has a tetragonal pseudocell with $c/a \gtrsim 1$ in which the fluorine octahedra about the manganese remain essentially regular but tilt relative to the crystal axes. At 84°K, just below the Néel temperature of 88°K, the pure antiferromagnetic also has a tetragonal pseudocell, but with $c/a < 1$ and the still essentially regular octahedra rotated as well as twisted. Below a second magnetic transition at 81.5°K, the 65°K structure shows in addition a significant distortion of the regularity of the octahedra.

2465 THEORY OF THE MAGNETIC ANISOTROPY IN $KMnF_3$.
J.J.Pearson.
Phys. Rev. (USA), Vol. 121, No. 3, 695-762 (Feb. 1, 1961).

A theoretical calculation is made of the magnetic anisotropy in the cubic perovskite structure of $KMnF_3$ at room temperature and in its distorted structures at lower temperatures. These distortions are of two types: first, a small tetragonal distortion of the entire crystal; and then, below the antiferromagnetic Néel point, a distortion of the octahedron of fluorine atoms surrounding each manganese. The cubic anisotropy is obtained from a general spin-wave calculation of the zero-point dipole—dipole energy in a cubic antiferromagnet. The result is found to be the same as that for the ferromagnetic case. The anisotropy from the tetragonal distortion is obtained from the change in the classical Lorentz factors. In calculating the effect of the fluorine distortion, a generalization is introduced of Kondo's method for obtaining the anisotropic effective spin Hamiltonian produced by overlap and electron transfer between an Mn^{2+} ion and its nonmagnetic neighbours. In its present form the method permits the ready calculation of this anisotropy for any symmetry and number of neighbours. Comparison with the microwave resonance and torque measurements of Portis, Teaney, and Heeger (to be published) reveals the last effect to be the most important and confirms the form of the spin Hamiltonian found here and its approximate magnitude.

2466 ROLE OF DOUBLE EXCHANGE IN THE MAGNETIC STRUCTURE OF $Li_xMn_{1-x}Se$.
R.R.Heikes, T.R.McGuire and R.J.Happel, Jr.
Phys. Rev. (USA), Vol. 121, No. 3, 703-7 (Feb. 1, 1961).

The details of the magnetic behaviour are attributed to the double-exchange interaction. At low temperatures, the hole which is introduced by the Li^+ is loosely bound to the Li^+ itself. In the region of the Li ion, double exchange causes local distortions of the spin system which are referred to as clusters. As the Li concentration is increased ($x = 0.07$), the clusters overlap sufficiently so that a magnetic field will induce an appreciable magnetic moment (0.5 μ_B). At temperatures below 45°K a canted spin ordering is suggested as the magnetic model for the $x = 0.07$ composition. Finally, at $x = 0.10$ it is found that spontaneous magnetization develops below 110° K. As the temperature is lowered through 70°K the spontaneous moment disappears and antiferromagnetism is found. It is not inconsistent with the data for $x = 0.10$ that this antiferromagnetic state is a canted-spin system with very small canting angle and therefore small magnetic moment. The theory of de Gennes is used in a discussion of the magnetic model.

2467 MAGNETIC STRUCTURE TRANSITIONS IN $Li_xMn_{1-x}Se$.
S.J.Pickart, R.Nathans and G.Shirane.
Phys. Rev. (USA), Vol. 121, No. 3, 707-14 (Feb. 1, 1961).

The magnetic structures occurring in lithium-substituted manganese selenide were examined by low-temperature powder neutron diffraction measurements. The composition with $x = 0.05$ retains the f.c.c. ordering of the second kind found in MnSe, the transition temperature being lowered to 83°K. For $x = 0.07$ the same type of ordering sets in at 73°K, but the spin direction changes abruptly as the temperature is lowered through 45°K; furthermore, the superlattice intensities decrease when an external magnetic field is applied along the scattering vector. At $x = 0.10$, the spontaneous moment observed at 77°K by magnetization measurements is shown to be ferromagnetic, again by means of an external field, and a transition is found at 71°K from ferromagnetism to antiferromagnetism with the third kind of ordering. The results are discussed with relation to models containing canted spins and multiple antiferromagnetic axes.

2468 FERROMAGNETISM OF A DISORDERED MAGNETIC LATTICE AT LOW TEMPERATURE. J.Seiden.
C.R. Acad. Sci. (France), Vol. 251, No. 9, 1062-4 (Aug. 29, 1960).
In French.

2469 QUANTUM THEORY OF UNIAXIAL ANISOTROPIC FERROMAGNETIC CRYSTALS.
S.V.Tablikov and T.Shiklosh [Siklós].
Acta phys. Hungar., Vol. 12, No. 1, 35-46 (1960). In Russian.

The anisotropy of the magnetic properties of ferromagnetic crystals is treated as the result of the anisotropy of the interactions between the electrons of the unfilled subshells. For the calculation of the magnetization as a function of temperature and external magnetic field, two-time advanced and retarded Green functions are used, according to the method given previously by the authors (Abstr. 10621 of 1959; 1205 of 1961). The results obtained are valid for all temperatures and external magnetic fields.

2470 INVESTIGATION OF THE MAGNETIC PROPERTIES OF GOLD–MANGANESE COMPOUNDS.
ohen, G.Quezel and G.Rimet.
romagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 0) p. 74-77. In German.
The manganese atoms in manganese–gold compounds have a gnetic moment of 5.6 Bohr magnetons. Even in compounds taining less than 5% Mn a magnetic interaction persists. At low peratures the compounds are ferromagnetic and their remanence roportional to the square of manganese concentration. Spin pling between non-nearest manganese neighbours must be umed for the interaction mechanism. R.Parker

2471 THE APPEARANCE OF CARBON STEEL WITH SQUARE-LOOP CHARACTERISTICS. G.Krüger.
romagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 0) p. 155-67. In German.
If carbon steel is slowly deformed by cold drawing and cold ing, a material possessing uniaxial anisotropy is obtained and material shows a (magnetic hysteresis) square loop racteristic. Changes in the characteristics resulting from ealing at moderately high temperatures are discussed. C.A.Hogarth

2472 CHANGES OF COERCIVITIES BY HEAT TREATMENT AND COLD-ROLLING IN Cu–Co ALLOY.
atō and T.Mitui.
hys. Soc. Japan, Vol. 14, No. 9, 1254 (Sept., 1959).
Results are presented for an alloy containing about 2 wt.% Co d at temperatures up to 750°C and cold rolled to 90% reduction. A.J.Manuel

2473 ON THE COERCIVITY OF ZONE REFINED IRON.
A.Mager and H.Hillman.
urwissenschaften (Germany), Vol. 47, No. 23, 537 (1960).
erman.
Results for the dependence of coercivity on zone velocity are n. A minimum value of 0.016 Oe was obtained after 5 passes owed by hydrogen annealing. A.J.Manuel

2474 COERCIVITY IN NICKEL AND IRON–NICKEL SINGLE CRYSTALS WITH PLASTIC DEFORMATION.
neller, T.Nagashima and G.Schmelzer.
romagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 0) p. 30-9. In German.
The relationship between coercivity in plastically deformed le crystals and the flow-tension shows three distinct regions, h are related to the mechanical properties. The rise in coerty is primarily due to the interaction between the magnetization or and dislocations. The influence of anisotropy of deformation iscussed. R.Parker

2475 THE COERCIVITY OF PLASTICALLY DEFORMED NICKEL SINGLE CRYSTALS. G.Rieder.
romagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of) p. 40-50. In German.
The temperature dependence of coercivity of plastically defornickel–iron single crystals is explained in terms of the modern lts of the theory of internal stresses and plasticity. The tempe- re range considered extends from the region of the maximum to low temperatures. The influences of a number of demagneion processes is considered. R.Parker

2476 THERMOMAGNETIC NERNST–ETTINGSHAUSEN EFFECTS IN MAGNETITE.
Samokhvalov and I.G.Fakidov.
Metallov i Metallovedenie (USSR), Vol. 9, No. 1, 31-5 (1960).
ussian.
The longitudinal and transverse Nernst–Ettingshausen effects agnetite were observed over the temperature range 80-400°K, ring the ordinary ferrimagnetic state and the low-temperature formation. Information about the laws obeyed by these effects s semiconductor was obtained. In the region of the low- erature transformation the effects displayed sharp anomalies, aling the reorganization of the energy spectrum of the conduction rons in this substance. N.Davy

2477 CURIE POINT IN THIN Ni FILMS DETERMINED BY ELECTRICAL METHOD. K.Kuwahara.
ys. Soc. Japan, Vol. 14, No. 9, 1247 (Sept., 1959).
The resistance and magneto-resistance of thin evaporated and subsequently vacuum-annealed films are reported as a function of temperature and the Curie points are inferred from the electrical data. Curie points drop rapidly below that of the bulk material for a film thickness of less than 40 A. No information concerning the measurement of film thickness is given. R.Parker

2478 OBSERVATION OF DOMAINS IN IRON WHISKERS UNDER HIGH FIELDS.
C.A.Fowler, Jr, E.M.Fryer and D.Treves.
J. appl. Phys. (USA), Vol. 31, No. 12, 2267-72 (Dec., 1960).
An improved instrument utilizing the longitudinal Kerr magneto-optic effect is used to observe the magnetic domain development in iron whiskers undergoing a magnetization cycle. It is found that domains persist at the tip of the whisker even under conditions for which the crystal is usually assumed to be saturated. Under applied fields of a few thousand oersteds these persistent domains at the tip, in all of the specimens observed, are magnetized perpendicular to the axis of the whisker and in the same sense around its lateral faces. It is proposed that these domains are caused by the high fields localized near the sharp corners and edges of the crystal.

2479 ELECTRON-OPTICAL STUDIES OF WEISS DOMAINS IN THIN LAYERS OF IRON.
H.Boersch, H.Raith and D.Wohlleben.
Z. Phys. (Germany), Vol. 159, No. 4, 388-96 (1960). In German.
The degrees of order which determine the properties of ferromagnetic layers can be differentiated in the electron microscope using a Schlieren technique. A special form of contrast aperture is used, containing two circular holes, placed 1 μ apart when using an objective of 5 mm focal length. R.Reed

2480 MAGNETIC ANISOTROPY OF EVAPORATED FILMS FORMED IN MAGNETIC FIELD.
M.Takahashi, D. Watanabe, T.Sasagawa, H.Saito and S.Ogawa.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1459-60 (Oct., 1959).
Torque curves have been obtained for Fe, Co, Ni and Fe–Ni, evaporated in the presence of a magnetic field, onto a quartz substrate, at room temperature and at 300°C. In all cases except Ni a uniaxial anisotropy is shown which can be represented by $Ku \sin 2\theta$. Less anisotropy is shown for evaporation when the substrate is at the higher temperature. The results for nickel depend on the time since evaporation. A.J.Manuel

2481 TIME DECREASE OF PERMEABILITY IN SILICON–IRON.
K.Tsushima, M.Asanuma and S.Miyahara.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1253-4 (Sept., 1959).
The activation energy for diffusion derived from time decrease in permeability in 4% Si–Fe is in agreement with the activation energy for diffusion of carbon in α-iron. A.J.Manuel

2482 MAGNETIC STRUCTURE OF THE HOLMIUM GARNET AT LOW TEMPERATURE [4.2°K].
A.Herpin, W.C.Koehler and P.Mériel.
C.R. Acad. Sci. (France), Vol. 251, No. 14, 1359-61 (Oct. 3, 1960). In French.

CONNECTION BETWEEN THE MAGNETIC PROPERTIES AND SENSITIVITY OF MAGNETOSTRICTIVE NICKEL–ZINC FERRITE PICKUPS. See Abstr. 2487

THE CRYSTAL STRUCTURE AND MAGNETIC STRUCTURE OF NIOBATES AND TANTALATES OF BIVALENT TRANSITION METALS. See Abstr. 2535

2483 HIGH-PERMEABILITY, LOW-LOSS MELT-FERRITE.
F.Bergmann.
Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960) p. 202-3. In German.
Improvements in the manganese–zinc ferrite of the melt type are reported. The specimens were prepared by two different methods. In one method the metals used as starting products melt and oxidize in a current of oxygen, while in the other method, the initial product is a mixture of oxides which is heated to melting point by an electric current. The composition of the charges in the investigation reported was approximately 53 mol.% Fe_2O_3, 29 mol.% MnO and 18 mol.% ZnO. Initial permeabilities of 2500-3000 are obtained for the ferrite. The time variation and the temperature coefficient of the initial permeability are low. D.S.Parasnis

2484 ELECTRIC RESISTANCE AND CATION DISTRIBUTION OF Fe–Mn FERRITE SYSTEM.
Z.Funatogawa, N.Miyata and S.Usami.
J. Phys. Soc. Japan, Vol. 14, No. 6, 854 (June, 1959).

The distribution of Mn-ions on the crystal lattice points in $Mn_xFe_{3-x}O_4$ ($0 \leq x \leq 1.14$) has been estimated from the results of electrical resistance measurements in the temperature range 100-280° K. It has been concluded that Mn-ions should occupy the B-sites of the spinel lattice, at least in the region of low Mn-ion content. The results of magnetocrystalline anisotropy measurements indicate a minimum of $(-K_1/M)$ in the region $0.6 < x < 0.7$ when the sign changes. S.A.Ahern

2485 THE AGING OF PERMEABILITY IN MANGANESE–ZINC FERRITE. S.Miyahara and T.Yamadaya.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1635 (Nov., 1959).

Measurements of permeability on samples of the nominal concentration $(Mn_{0.5}Zn_{0.5})O.Fe_2O_3$ using an a.c. bridge at 1 kc/s after various demagnetization processes show that decrease of permeability after sintering is due to disaccomodation and not to irreversible structure changes. S.A.Ahern

2486 SOME EXPERIMENTAL RESULTS ON THE DIFFUSION AFTER-EFFECT IN NICKEL–COBALT FERRITES.
P.Vigier.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1471-3 (Oct. 10, 1960). In French.

The effect is observed between −200° and 100° C on specimens subjected to magnetic fields of duration of about 10^{-3} sec. E.P.Wohlfarth

2487 CONNECTION BETWEEN THE MAGNETIC PROPERTIES AND SENSITIVITY OF MAGNETOSTRICTIVE NICKEL–ZINC FERRITE PICKUPS.
A.D.Sokolov and Y.S.Shur.
Akust. Zh. (USSR), Vol. 6, No. 1, 131-3 (1960). In Russian. English translation in: Soviet Physics-Acoustics (USA), Vol. 6, No. 1, 130-2 (July-Sept., 1960).

It had been shown previously[Shur et al., Trudy Instituta Fiziki Metallov, UFAN SSSR, Vol. 20, 131-140 (1958)] that the sensitivity of a ferromagnetic metal as a magnetostrictive pickup can be assessed from the relation $e_{max} \sim \mu_0 \lambda_s/I_s$, where e_{max} is the maximum value of the e.m.f. induced in the windings of the pickup with a specified acoustic pressure and optimum magnetization; μ_0, λ_s and I_s have their usual meanings. This paper reports an investigation on the validity of this relation for ferrites. Measurements were made on the following ferrites:- nickel ferrite, nickel–cobalt ferrite of five compositions. The form of the results indicates that the relationship $e_{max} \sim \mu_0 \lambda_s/I_s$ is valid. S.A.Ahern

2488 MAGNETIC PROPERTIES OF MANGANESE NIOBATE AND OF COBALT NIOBATE.
R.Aléonard and R.Pauthenet.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1730-2 (Oct. 24, 1960). In French.

These two niobates are antiferromagnetic. For manganese niobate, $Nb_2O_5.4MnO$, the Néel temperature is 125° K, and the Curie temperature −250° K; above the Néel temperature the χ^{-1}–T curve defines a Curie constant C = 4.31 per Mn^{2+} ion. For cobalt niobate observation of antiferromagnetism is more difficult; above 30° K the χ^{-1}–T curve gives a Curie temperature of −10° K, and a Curie constant of 3.0 per Co^{2+} ion, which is in agreement with values obtained from other cobalt salts. No definite antiferromagnetic peak is, however, observed. This is ascribed to the effect of magnetocrystalline anisotropy on the antiferromagnetic susceptibility. S.A.Ahern

Magnetic Resonances

2489 ON THE THEORY OF FERROMAGNETIC RESONANCE. II. S.V.Tyablikov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2009-18 (Sept., 1960). In Russian.

For previous part, see Abstr. 8077 of 1960. In connection with ferromagnetic resonance, an expression for the magnetic susceptibility tensor is derived by a method employing Green's functions of the temperature. Some of its general properties, independent of the form of the Hamiltonian, are determined. The calculations lead to a linear approximation to the intensity of the radiofrequency field. [English translation in: Soviet Physics–Solid State(USA)]. N.Davy

2490 NOTE ON FERROMAGNETIC RELAXATION EQUATIONS. H.Suhl and R.C.Fletcher.
J. appl. Phys. (USA), Vol. 32, No. 2, 281-2 (Feb., 1961).

An amplitude formulation is employed for determining the motion of the electron spins in a ferromagnetic insulator in the presence of scattering from inhomogeneous. This formulation justifies the omission of an explicit back reaction term in previous "energy" and "number of quanta" formulations in the usual case where a large number of spin waves are excited by the scattering centres. The excited spin waves add up in such an incoherent fashion that they do not react back on the principal mode.

2491 EXCHANGE INTEGRAL IN COBALT FROM SPIN-WAVE RESONANCE. P.E.Tannenwald and R.Weber.
Phys. Rev. (USA), Vol. 121, No. 3, 715 (Feb. 1, 1961).

The exchange constant A and exchange integral J, and their temperature dependences, were measured in cobalt metal films by the method of spin-wave resonance (Abstr. 4808 of 1959). At room temperature, $A = 1.30 \times 10^{-6}$ erg/cm and J = 155k. J is temperature independent between 4° K and 295° K. Comparison is made with recent data obtained by other experimental methods.

2492 THE EFFECT OF DIMENSIONS AND COUPLING FOR CIRCULARLY POLARIZED MAGNETOSTATIC MODES IN A SMALL FERRITE SPHERE. R.Plumier.
C.R. Acad. Sci. (France), Vol. 251, No. 14, 1356-8 (Oct. 3, 1960). In French.

The introduction of the Maxwell displacement current leads to two modifications in the results obtained using the magnetostatic approximation for the magnetostatic modes in ferromagnetic resonance. The two corrections, displacement of the frequency and coupling between modes, are examined for modes of the type (n, n, 0) and (n, n-1, 0). S.A.Ahern

2493 SUBSIDIARY RESONANCE IN THE COINCIDENCE REGION IN YTTRIUM IRON GARNET. F.C.Rossol.
J. appl. Phys. (USA), Vol. 31, No. 12, 2273-5 (Dec., 1960).

The measurement of h(critical), the threshold r.f. field for subsidiary resonance, as a function of frequency throughout the coincidence region, and the behaviour of μ''_{max} at r.f. fields exceeding h critical) are presented for a single-crystal yttrium iron garnet sphere at room temperature. The sphere has a linewidth of 480 mOe measured at 3000 Mc/s. The curve obtained was quite flat at approximately 0.3 mOe from 2000 Mc/s to 3300 Mc/s and increased by more than a factor of 6 within 150 Mc/s of either end; a much more sudden increase than was the case for previously measured spheres of wider linewidth. The measured curve is compared to a curve computed from Suhl's theory of subsidiary resonance at high power levels, and the effects of the linewidths ΔH and ΔH_k on the shape of the curve are considered. The variation of μ''_{max} with r.f. power above the threshold followed Suhl's $P^{-1/2}$ law rather closely for frequencies above 2700 Mc/s but exhibited fine structure and a slower fall-off for frequencies below.

2494 LONGITUDINAL FERRIMAGNETIC RESONANCE. R.K.Wangsness.
Phys. Rev. (USA), Vol. 121, No. 2, 472 (Jan. 15, 1961).

Susceptibility components are calculated for a triangular ferrimagnetic system when the oscillating field is parallel to both the constant field and the net magnetization. Two new effects are found which are analogous to that discussed previously. They consist in the production of oscillating magnetization components of the same frequency as the external field and which are parallel and perpendicular to the net magnetization.

2495 AN ELECTRON SPIN RESONANCE STUDY OF MANGANESE IMPURITY IN BRUCITE.
W.A.Pieczonka, H.E.Petch and A.B McLay.
Canad. J. Phys., Vol. 39, No. 1, 145-57 (Jan., 1961).

A single crystal of brucite, $Mg(OH)_2$, containing manganese impurity to the extent of 100 parts per million, was studied at room and liquid air temperatures. The observed absorption spectrum has been successfully interpreted in terms of parameters found in the appropriate spin-Hamiltonian. The measured values of these para-

ers at room temperature were found to be:

= 2.0001 ± 0.0005, $g_\perp$ = 2.0005 ± 0.0005,
= −7.20 ± 0.25 × 10^{-4} cm^{-1}, a = +10.82 ± 0.45 × 10^{-4} cm^{-1},
= −85.7 ± 0.4 × 10^{-4} cm^{-1}, B = −84.9 ± 0.6 × 10^{-4} cm^{-1}.

2496 PARAMAGNETIC RESONANCE OF Fe^{3+} IN OCTAHEDRAL AND TETRAHEDRAL SITES IN YTTRIUM LLIUM GARNET (YGaG) AND ANISOTROPY OF YTTRIUM N GARNET (YIG). S.Geschwind.
s. Rev. (USA), Vol. 121, No. 2, 363-74 (Jan. 15, 1961).

The e.s.r. spectrum of a small Fe^{3+} impurity which enters stitutionally for the gallium in single crystals of yttrium ium garnet ($Y_3Ga_5O_{12}$) was examined at 24 kMc/s at 295° and K. Fe^{3+} is studied for the first time in tetrahedral coordination. results for the crystal field parameters that appear in the al spin Hamiltonian for Fe^{3+} for the octahedral (a) and tetrahedral sites are: a_a = +0.0185 cm^{-1}, D_a = −0.1294 cm^{-1}, = +0.0026 cm^{-1}, a_d = +0.0062 cm^{-1}, D_d = −0.0880 cm^{-1}, = −0.0037 cm^{-1}. The finding of positive values of a in both types site where the cubic crystalline potential, V, has opposite signs cates that, in the mechanism responsible for this splitting, terms portional to even powers of V are dominant. Using the experitally determined crystal field parameters of Fe^{3+} in YGaG, the -temperature anisotropy energy per unit cell in the isostructural rimagnet, YIG, is predicted as K_1 = −0.370 cm^{-1}. This is 50% ger than the experimental value K_1 = −0.250 cm^{-1} and several rces for the origin of this discrepancy are suggested.

2497 NUCLEAR MAGNETIC RESONANCE OF Na^{23} IN SODIUM CHLORIDE CRYSTALS.
tsuka, Y.Oshio, T.Kobayashi and H.Kawamura.
Phys. Soc. Japan, Vol. 14, No. 10, 1454 (Oct., 1959).

The second moments for two perfect crystals agree with the oretical dipolar widths. This shows that the extra width norly observed is due to lattice imperfections. Values of T_1 are ple-dependent but it is not yet possible to account for the difences which may be due to impurities or dislocations.

D.J.Oliver

2498 KNIGHT SHIFT IN POTASSIUM.
F.J.Milford and W.B.Gager.
s. Rev. (USA), Vol. 121, No. 3, 716-20 (Feb. 1, 1961).

The K^{39} nuclear magnetic resonance was observed in metallic ssium and in aqueous solutions of KNO_3 and $K_3Co(CN)_6$. From e observations a Knight shift of (0.248 ± 0.005)% was obtained. g Pines' value 0.60 × 10^{-6} for the spin susceptibility gives 0.95 a_0^{-3}. This is compared with the theoretical values 6 a_0^{-3} obtained by Callaway and 0.909 a_0^{-3} obtained by a quantum ct calculation in this paper.

2499 NUCLEAR SPIN–SPIN COUPLING BETWEEN PROTONS IN VINYL DERIVATIVES.
imizu, S.Matsuoka, S.Hattori and K.Senda.
Phys. Soc. Japan, Vol. 14, No. 5, 683-4 (May, 1959).

Spin–spin coupling constants of styrene, trans-cinnamic hyde and coumarine were measured. The coupling constant veen protons bonded to the same carbon atom in vinyl groups was ll, but it was far larger between protons in the cis- and transtions separated by two carbon atoms. S.A.Ahern

MECHANICAL PROPERTIES OF SOLIDS

2500 SUMMARIZED PROCEEDINGS OF A CONFERENCE ON STRESS ANALYSIS — UNIVERSITY COLLEGE OF TH STAFFORDSHIRE, APRIL 1960. C.D.Pomeroy.
J. appl. Phys., Vol. 12, No. 1, 3-7 (Jan., 1961).

The annual conference of the Stress Analysis Group of The tute of Physics was held at the University College of North ordshire, Keele, Staffordshire, from 11th to 13th April 1960. papers, which were concerned primarily with polymers and s, are summarized.

2501 THE EXPERIMENTAL DETERMINATION OF HIGHER-ORDER ELASTIC CONSTANTS. A.Seeger and O.Buck.
Z. Naturforsch (Germany), Vol. 15a, No. 12, 1056-67 (Dec., 1960). In German.

In the application of the non-linear theory of elasticity a knowledge of the third-order elastic constants is required. Various methods are mentioned for the experimental determination of these constants and, where required, the formulae for the evaluation of the experiments are derived. A critical compilation is given of the available data on third-order elastic constants. A complete set is given for germanium single crystals (6 constants) and for polycrystalline copper and iron (3 constants).

2502 DYNAMIC MECHANICAL PROPERTIES OF POLYMERS AT ULTRASONIC FREQUENCIES IN RELATION TO THEIR GLASS TRANSITION PHENOMENA.
Y.Wada, H.Hirose, T.Asano and S.Fukutomi.
J. Phys. Soc. Japan, Vol. 14, No. 8, 1064-72 (Aug., 1959).

The different methods used for determining the "glass transition temperature," which represents the dividing line between glass-like and rubber-like properties of a polymer, are described. The results of measurements made at 33, 66 and 100 kc/s of the variation with temperature of the complex modulus, rigidity and bulk modulus of polystyrene, polymethyl methacrylate, polyvinyl acetate and phenol resin are given and comment is made on some of the anomalies observed in the modulus-temperature curves below the glass transition temperature. H.J.H.Starks

2503 INVESTIGATION OF THE ELASTIC [AND SHEAR] MODULI OF METALS UNDER HYDROSTATIC PRESSURES UP TO 4000 kg/cm^2 BY STATIC METHODS.
Z.I.Stakhovskaya and I.S.Tomashevskaya.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 589-92 (April, 1960). In Russian.

On increasing the hydrostatic pressure, p, to 1000 kg/cm^2 the Young's modulus of Armco Fe, brass, and Cu increased by 5, 7.5, and 1.2%, respectively, remaining constant at 1000 < p < 4000 kg/cm^2. The shear modulus of Fe was not affected by the variation of p, but that of brass and Duralumin increased by 3-6% when p was raised to 1000 kg/cm^2. M.H.Sloboda

2504 THE VARIATION WITH TEMPERATURE OF YOUNG'S MODULUS FOR SOME URANIUM ALLOYS AND FOR THORIUM, VANADIUM AND NIOBIUM. D.J.Livesey.
J. Inst. Metals (GB), Vol. 88, Pt 3, 144 (Nov., 1959).

Measurements were made over the range 20° to 500° C on uranium and two alloys, one containing 0.5 at.% molybdenum and the other 0.5 at.% chromium. A resonance method was used. The variation with temperature was similar for uranium and the alloys. At 20° C the value is about 19 × 10^{11} dynes/cm. The moduli for thorium, vanadium and niobium were measured over a smaller temperature range. A.E.Kay

2505 CHANGES IN THE STRESS–STRAIN PROPERTIES OF NATURAL RUBBER VULCANIZATES DURING AGEING.
J.R.Dunn and J.Scanlan.
Trans Faraday Soc. (GB), Vol. 57, Pt 1, 160-6 (Jan., 1961).

Stress–strain measurements were made at intervals during the ageing of a peroxide vulcanizate and a sulphenamide-accelerated sulphur vulcanizate of natural rubber. Recent work on the relationship between the structure of vulcanizates of natural rubber and the appearance of non-Gaussian effects in their elastic behaviour makes possible the deduction of information on the nature of the ageing reactions from these measurements. The stress–strain measurements support previous conclusions that the sulphurless vulcanizate degrades because of oxidative scission of the polymer chains. The measurements indicate that the ageing of the sulphur vulcanizate is also due to scission of the polymer chains, possibly at the cross-links, rather than of the cross-links themselves and is accompanied by the formation of additional cross-links.

2506 ON THE PROBLEM OF INTERNAL FRICTION IN A MATERIAL. V.T.Troshchenko.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 6, 1060-9 (June, 1960). In Russian.

The author looks for a physical basis to the empirical equations for elastic hysteresis put forward by Davidenkov [Zh. tekh. Fiz., Vol. 8, No. 6 (1938)], assuming that internal friction is due to microplastic deformations. An expression is derived for the energy produced per deformation cycle and this agrees with the empirical rule.

It is shown that the dissipated energy depends on the detailed structure of the sample, on its dimensions and the form of the stressed state. Expressions for the relative cyclic viscosity are derived for several stressed states and these agree with experiment. [English translation in: Soviet Physics—Solid State (USA)].
M.G.Priestley

2507 THE EFFECT OF QUENCHING AND NEUTRON IRRADIATION ON INTERNAL FRICTION OF ALUMINUM—5% MAGNESIUM ALLOY. W.G.Nilson.
Canad. J. Phys., Vol. 39, No. 1, 119-32 (Jan., 1961).

Low frequency internal friction data were obtained to determine the effects of quenching and neutron irradiation on solute movement. A damping peak near 150° C, attributed to stress-induced reorientation of solute atoms, was found to be shifted to lower temperatures by these treatments. This behaviour corresponds to a reduction in relaxation time for the damping process, and is compatible with the idea that the solute atoms act as traps for vacancies.

2508 A DEFORMATION CALORIMETER. R.O.Williams.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1336-41 (Dec., 1960).

A calorimeter has been constructed which adiabatically deforms metals with a known mechanical energy. The energy which is stored in the sample as a result of the deformation is the difference between the supplied energy and the heat which is found by the increase in sample temperature. It is also possible to follow subsequent energy releases which take place immediately following the deformation; for some materials this release can be an appreciable fraction of the stored energy. The results for the stored energy are considered to be accurate to approximarely 10%.

2509 X-RAY OBSERVATIONS OF THE SURFACES OF PLASTICALLY DEFORMED LiF CRYSTALS WITH THE BERG—BARRETT METHOD. M.Yoshimatsu and K.Kohra.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1249-50 (Sept., 1959).

The surfaces of LiF crystals were observed by the Berg—Barrett method after cleaving, thermal quenching, or mechanical bending. The various phenomena noted include asymmetry at grain boundaries, clusters of dislocations, and slip lines. J.Thewlis

2510 INTERACTIONS BETWEEN GLIDE DISLOCATIONS IN A DOUBLE PILE-UP IN α-IRON.
Y.T.Chou, F.Garofalo and R.W.Whitmore.
Acta metallurgica (Internat.), Vol. 8, No. 7, 480-8 (July, 1960).

The equilibrium distribution of arrested glide dislocations on two intersecting slip planes in α-iron is computed taking into account the elastic anisotropy. From the equilibrium distribution of dislocations, calculation is made of the stresses near the tip of the double pile-up (that is, a pile-up on each of two intersecting slip planes). For fifty dislocations the shear stress at the tip of a double pile-up is calculated to be 1360 σ_0, where σ_0 is the applied stress in the slip plane. This stress is greater by a factor of 27 than the tip stress of a single pile-up of the same size. The high stress concentration at the tip of a double pile-up indicates, as suggested by Cottrell, that such a dislocation arrangement could lead to initiation of cleavage cracks in α-iron.

2511 ON THE SLIP LINE PATTERN OF FACE-CENTERED CUBIC METAL CRYSTALS. S.Mader and A.Seiger.
Acta metallurgica (Internat.), Vol. 8, No. 8, 513-22 (Aug., 1960).
In German.

Using copper as an example, the so-called normal slip line pattern of face-centred cubic metal crystals is discussed. The normal pattern is perturbed by the appearance of striae and kink bands. Their variation with strain is examined, particularly in relation to stages I, II, III of the stress—strain curve. The striae turn out to be a coarse form of the strain inhomogeneities, which are observed by the electron microscope in the "structurized fine slip" of stage II. Two different types of kink bands, associated with two modes of formation, have to be distinguished. One of these types occurs in stage III of the stress—strain curve only. It is a consequence of the thermally activated cross slip occurring in stage III. It is shown that the fragmentation (cell formation) of deformed crystals is a closely related phenomenon.

2512 SLIP AT TWIN BOUNDARIES ON DIRECT AND RETROGRESSIVE TWINNING OF IRON.
I.A.Gindin and Ya.D.Staradubov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 6, 1079-81 (June, 1960).
In Russian.

Twinning produced by compression in pure iron at 77° K was studied by a microinterferometer method and by a method involving the use of graduation lines. The results are illustrated by numerous photographs. The shear direction corresponding to slip in the twinning plane was determined theoretically. High plasticity at low temperatures depended to a considerable extent on macroscopic slip in the twinning plane. Application of a tensile stress lead to removal of twinning, i.e. to retrogressive twinning. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

2513 MEASUREMENT OF SLIP (Ko) AND VISCOUS (Bo) FLOW COEFFICIENTS OF PERMEABLE SOLIDS.
J.G.Biram.
Nature (GB), Vol. 187, 865 (Sept. 3, 1960).

A new method of measurement, involving only observations of the flow and of the pressures at three points, all at a single mean pressure, is shown to be possible in principle. J.G.Oldroyd

2514 EFFECTS OF NON-UNIFORMITIES ON THE HARDENING OF CRYSTALS. R.L.Fleischer.
Acta metallurgica (Internat.), Vol. 8, No. 9, 598-604 (Sept., 1960).

The ease of motion of a dislocation in a crystal is influenced by changes in lattice parameter and elastic modulus. For solid solutions where such changes are gradual the hardening is negligible, but for abrupt changes, such as occur at a precipitate, the effect is important. The changes in lattice parameter lead to the production of interface dislocations and suggest a work hardening model for one class of precipitation hardened alloys. Interface dislocations may also affect flow near a free surface.

2515 THE INFLUENCE OF STRAIN AMPLITUDE ON THE WORK HARDENING OF COPPER CRYSTALS IN ALTERNATING TENSION AND COMPRESSION.
D.S.Kemsley and M.S.Paterson.
Acta metallurgica (Internat.), Vol. 8, No. 7, 453-67 (July, 1960).

For a given cumulative strain, the work hardening of copper crystals in alternating straining is always less than in a tensile test. At a plastic-strain amplitude of 0.0001, the hardening is very low and nearly the same for all orientations. For larger amplitudes the behaviour varies widely with orientation; in general, the rate of work hardening increases steadily with strain amplitude, but for orientations away from [110] there is a sharp increase in hardening rate above a certain amplitude. In this rapid hardening stage, prominent secondary slip is observed, which is otherwise absent. It is suggested that there are two principal mechanisms of hardening: (a) a basic hardening similar to that in stage I of tensile tests, during which slip is mainly confined to the primary plane; (2) a rapid hardening, resulting from extensive obstruction of the primary slip by slip on secondary planes. The mutual interference of slip in two directions in the primary plane may also be important for some orientations.

2516 DISLOCATIONS AND BRITTLE FRACTURE IN ELEMENTAL AND COMPOUND SEMICONDUCTORS.
M.S.Abrahams and L.Ekstrom.
Acta metallurgica (Internat.), Vol. 8, No. 9, 654-62 (Sept., 1960).

The predominant {110} cleavage plane of the IIIb—Vb compounds has been explained by employing a dislocation model. This model postulates the formation and coalescence of Lomer dislocations to form (nucleate) a microcrack; cleavage results from the propagation of the microcrack. Unlike previous models, the one herein proposed is able to account for the unique three-fold symmetry of the crack pattern which results from indenting a (111) surface with a pointed, conical diamond. The fact that Ge only exhibits {110} cleavage under special conditions is attributed to a difference in structure of the Lomer dislocation between IVb elements and IIIb—Vb compounds. The occurrence of octahedral cleavage in the IVb elements is thought to be due to the growth of microcrack resulting from the piling-up and coalescence of glissile dislocations on {111} planes. A combination of this mechanism with the one yielding dodecahedral cleavage accounts for cleavage on planes other than those of the {110} type in the IIIb—Vb compounds.

2517 EFFECT OF HYDROGEN ON STABILITY OF MICRO CRACKS IN IRON AND STEEL.
F.Garofalo, Y.T.Chou and V.Ambegaokar.
Acta metallurgica (Internat), Vol. 8, No. 8, 504-12 (Aug., 1960).

Much evidence is available which indicates that hydrogen embrittlement and propagation of internal cracks in iron and steel are promoted by hydrogen gas in voids or micro cracks which may

be formed by plastic deformation. It seems likely that these micro cracks originate from a dislocation pile-up as suggested by Stroh. As shown by Stroh, a stable micro crack can exist in a metal until a critical external stress is reached when the micro crack becomes self propagating. For this condition, it is found that the Stroh relation is analogous to the Griffith and Cottrell relations and differs from these only by a constant factor. As shown in this paper, a Stroh crack also ceases to be stable when a critical internal pressure is reached in the absence of an external stress. It is shown that in iron and steel, the amount of hydrogen needed to reach the critical pressure is within the range found experimentally for extensive internal cracking. The stability of a micro crack is also considered for the condition of an imposed external stress and internal pressure. It is predicted, as observed experimentally by others, that pronounced hydrogen embrittlement of iron or steel may be caused by as little as 2 cm^3 of hydrogen per 100 g of metal (approximately 2 p.p.m.).

STRUCTURE OF SOLIDS

2518 PHASE TRANSFORMATIONS IN CERIUM. C.J.McHargue and H.L.Yakel, Jr.
Acta metallurgica (Internat.), Vol. 8, No. 9, 637-46 (Sept., 1960).

The room temperature crystal structure of cerium which has not been cooled to lower temperature is face-centred cubic. The face-centred cubic structure transforms upon cooling to a hexagonal close-packed structure ($c/a = 3.239$) with a ABAC stacking sequence of close-packed planes. This transformation has many of the typical martensitic characteristics. The transformation starts at $263^\circ \pm 10^\circ$K. At 100°K, that portion of the face-centred cubic phase which has not transformed to hexagonal close-packed begins to transform to a second face-centred cubic phase with a volume decrease of 16.5%. The kinetics of this transformation also resemble that of the martensite reaction. Below a temperature between 77° and 43°K the hexagonal structure appears to also transform to the collapsed cubic form. Plastic deformation at any temperature suppresses the transformation to the hexagonal form and may even cause it to revert to the normal cubic form. Deformation below 100°K favours the collapsed cubic form. Thermal cycling produces more of the hexagonal phase than can be obtained on one cooling. After a large number of cycles, neither the hexagonal nor normal cubic phase will transform to the collapsed cubic phase upon cooling. Plastic deformation at 4.2°K removes the thermal cycling effects.

CRYSTALLOGRAPHY

2519 A TECHNIQUE FOR EXAMINATION OF THE EDGE FACES OF TABULAR MICROCRYSTALS APPLIED TO SILVER-BROMIDE GRAINS FOR EVIDENCE OF TWINNING. G.C.Garnell and F.S.Judd.
J. photogr. Sci. (GB), Vol. 9, No. 1, 67-9 (Jan.-Feb., 1961).

By coating spherical microcrystals on to a glass support prior to a coating of tabular microcrystals, many of the latter are tilted so that the topography of their edge faces is readily visible in carbon-replica electron micrographs. Electron micrographs are reproduced of tabular silver bromide microcrystals (grains) from a photographic emulsion examined in this way, which show that the edge faces of many grains are of the form to be expected if twinning had occurred during grain growth.

2520 PITTING OF ALUMINIUM AT GRAIN BOUNDARIES AFTER AGEING. G.A.Bassett and C.Edeleanu.
Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1217-20 (Dec., 1960).

Thin foils of 99.999 aluminium, prepared by electropolishing were found to develop surface pits along the grain boundaries during ageing at room temperature. It is suggested that the pits are formed by a vacancy mechanism, and that they are associated with the initiation of etch attack along the grain boundaries of aged pure aluminium.

2521 CHEMICAL ETCHING OF THE SURFACE OF IRON–NICKEL ALLOYS (50/50) TO EXPOSE DISLOCATIONS. W.D.Hannibal.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 835-6 (Sept., 1960).
In German.

Discusses possible chemical reactions taking place during chemical etching and electrolytic polishing. J.E.Caffyn

2522 ELECTROLYTIC ETCHING OF DISLOCATIONS IN SILICON IRON AS CAST. W.D.Hannibal.
Z. Naturforsch.(Germany), Vol. 15a, No. 9, 837-8 (Sept., 1960).
In German.

Apparatus which enables the metal surface to be observed microscopically during electrolytic etching at constant current and voltage was used with different etchants. J.E.Caffyn

2523 THEORY OF CRYSTAL GROWTH AND INTERFACE MOTION IN CRYSTALLINE MATERIALS. J.W.Cahn.
Acta metallurgica (Internat), Vol. 8, No. 8, 554-62 (Aug., 1960).

The theory of crystal growth for diffuse and for non-singular surfaces is re-examined. It is found that if a critical driving force is exceeded the surface will be able to advance normal to itself without needing steps; if this driving force is not exceeded lateral step motion is necessary. For extremely diffuse interfaces this critical driving force will be so small that any measurable driving force will exceed it. For sharp interfaces the critical driving force will be very large, and most growth will occur by lateral step motion. For most systems however the critical driving force should be accessible experimentally. In addition the nature of a step in a diffuse interface is discussed and its energy calculated. The conditions for interface motion by classical nucleation or screw dislocation mechanisms are derived.

DANGLING BONDS ON CRYSTAL FACES DURING GROWTH.
See Abstr. 2366

2524 VAPOR PHASE GROWTH AND PROPERTIES OF ZINC SULFIDE SINGLE CRYSTALS. H.Samelson.
J. appl. Phys. (USA), Vol. 32, No. 2, 309-17 (Feb., 1961).

The growth of single crystals by a sealed-tube vapour-phase method is described. In this system the parameters that are studied are the evaporation temperature, the temperature schedule during a run, the temperature gradient along the length of the tube, and, finally, the ambient pressure of H_2S in the tube. The resulting crystals are of a rodlike, distorted rodlike, or platelike habit, and the dominant habit, in any given run, is responsive to variations in the experimental parameters. An altogether different habit is observed in runs performed in a vacuum. The structure of the crystals varies from pure hexagonal to reversed cubic; most of the crystals exhibit stacking faults to various degrees. The structure is a function of the growth temperature. For crystals grown in an H_2S ambient, the mechanism proposed is an initial growth of a fine rod followed by a thickening of the rod and its possible subsequent development into a plate. The whisker growth is probably not a nucleation process and may proceed by a screw dislocation or stepped plane mechanism. The subsequent steps, as well as the growth of crystals in a vacuum are consistent with a surface nucleation mechanism.

2525 THE GROWTH OF LARGE SINGLE CRYSTALS OF ZINC OXIDE. J.W.Nielsen and E.F.Dearborn.
J. phys. Chem. (USA), Vol. 64, No. 11, 1762-3 (Nov., 1960).

Large single crystals of ZnO were grown from solution in molten PbF_2. The crystal habit changed from plates (normal to the c-axis) at 1150°C to drum shapes at 1050°C. D.G.Holloway

2526 THE FORMATION OF CRYSTAL LATTICES IN TITANATES DEPOSITED BY VACUUM EVAPORATION. O.Roder.
Z. angew. Phys. (Germany), Vol. 12, No. 7, 323-4 (July, 1960).
In German.

Disagreement concerning the conditions required for the formation of crystal lattices was investigated. The titanates were deposited by vacuum evaporation and annealed by heating in air up to 1000°C. They were scraped off from their supports and the powder subjected to Debye–Scherrer analysis. It was concluded that a minimum temperature of 400°C was essential for any formation of crystal lattice structure. W.Steckelmacher

2527 SIMPLE CONSTANT-TEMPERATURE LABORATORY CRYSTALLIZER. B.M.Bartlett.
J. sci. Instrum. (GB), Vol. 38, No. 2, 54-5 (Feb., 1961).

A description is given of a simple laboratory crystallizer employing a novel centrifugal system for the circulation of solution.

2528 ANALYTICAL SOLUTIONS FOR SOME ZONE MELTING PROBLEMS. H.Reiss and E.Helfand.
J. appl. Phys. (USA), Vol. 32, No. 2, 228-32 (Feb., 1961).

Analytical solutions to the zone melting problem are obtained

for any initial distribution of solute for the case of two geometries. One is the infinite straight bar and the other the re-entrant annular ring. The former is particularly interesting because under certain conditions the semi-infinite bar may be treated as infinite. The annular ring calculation provides, among other applications, a means of giving quantitative answers to questions arising in the zone levelling process.

2529 FLOATING ZONE CRYSTALS USING AN ARC IMAGE FURNACE. R.P.Poplawsky and J.E.Thomas, Jr.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1303-8 (Dec., 1960).

A floating zone technique for growing crystals of medium high melting point materials with an arc image furnace is presented. This technique has been successfully applied to silicon. The oxygen concentration, resistivities, and dislocation densities of resulting crystals were determined to make possible a comparison with crystals obtained by standard methods. In general this comparison is favourable. Considerations of floating zones, maximum power, and flux distribution indicate that floating zone techniques combined with an arc image furnace are promising in connection with the growth of good quality crystals of a variety of high melting point materials.

2530 SIMPLE APPARATUS FOR THE GROWTH OF GERMANIUM DENDRITES.
R.F.Lever, J.K.Powers, J.L.Richards and H.V.Sirgo.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1334-5 (Dec., 1960).

A simple resistance-heated apparatus for pulling Ge dendrites is described. Two distinct types of growth are obtainable. When the correct conditions are achieved, growth may continue indefinitely. A typical product is a 2 m length of essentially uniform ribbon 1.5 to 3 mm in width, and 0.1 mm thick.

CRYSTAL LATTICE STRUCTURES

2531 MODIFIED COAXIAL POWDER X-RAY CAMERA. D.J.Fisher.
Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1341-3 (Dec., 1960).

The camera employs a flat specimen mounted normal to the direct beam which proceeds along the axis of the cylindrical film, as first constructed by Hawes (Abstr. 9018 of 1959). Also presented are details of the techniques for mounting specimens, measuring films, and correcting these for errors.

2532 LATTICE-PARAMETER DETERMINATION FROM BROAD DIFFRACTION LINES. G.K.Schmidt.
Z. angew. Phys. (Germany), Vol. 12, No. 8, 347-51 (Aug., 1960). In German.

Using a Fourier-series expansion for the observed profile, the line profile on a perfect instrument, and the instrument weight function, three methods are described for determining the centre of the line and are compared with the centroid method in a numerical example. J.E.Caffyn

2533 CALCULATION OF THE INTERFERENCE FUNCTION OF DEBYE–SCHERRER DIAGRAMS PRODUCED BY VERY SMALL HOMOATOMIC CRYSTALS OF CUBIC FORM, CRYSTALLIZING IN THE F.C.C. SYSTEM. P.Larroque.
C.R. Acad. Sci. (France), Vol. 251, No. 19, 1992-4 (Nov. 7, 1960). In French.

Calculations have been made, and intensity curves are plotted for face-centred systems containing respectively 14, 63, 172, 365, 666 and 1099 atoms. See Abstr. 8085 of 1953. A.R.Stokes

DETERMINATION OF AVOGADRO'S NUMBER FROM DENSITY AND LATTICE CONSTANT MEASUREMENTS ON CRYSTALS. See Abstr. 1677

STRUCTURE OF VAPOUR-PHASE GROWN ZnS. See Abstr. 2524

2534 STRUCTURE INVESTIGATION OF CHROMIUM CARBIDE Cr_3C_2 BY THERMAL NEUTRONS.
D.Meinhardt and O.Krisement.
Z. Naturforsch. (Germany), Vol. 15a, No. 10, 880-9 (Oct., 1960). In German.

A conventional neutron diffractometer was used, employing single crystals of Pb or Cu as the monochromator. As stated by Westgren, the unit cell is orthohombic, space group D_{2h}^{16} - Pbnm (Pnm... but the positions of the C atoms were found to be different. The pa-... rameters of the atoms concerned were found to be

C_I atoms: x = 0.204 instead of 0.109
y = 0.092 instead of –0.100

C_{II} atoms: x = –0.048 instead of –0.057
y = 0.228 instead of 0.217.

J.Thewlis

NEUTRON POWDER DIFFRACTION INTENSITIES OF TbC_2, Yb... Yb, AND Lu: SCATTERING CROSS-SECTIONS OF Tb, Yb, AND Lu... See Abstr. 2219

2535 THE CRYSTAL STRUCTURE AND MAGNETIC STRUCTURE OF NIOBATES AND TANTALATES OF BIVALENT TRANSITION METALS.
F.Bertaut, L.Corliss and F.Forrat.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1733-5 (Oct. 24, 1960). In French.

The crystal structure of $Nb_2M_4O_9$ and $Ta_2M_4O_9$ (where M is Mg, ... Mn, Fe, Co, or Ni) is found by X-ray analysis to be of the corundum... α-alumina type. The magnetic structure shown by neutron diffraction measurements at room temperature, liquid nitrogen and ... liquid helium temperatures consists of antiparallel chains of spins M of the form $\frac{1}{3}\frac{2}{3}$ z and $\frac{2}{3}\frac{1}{3}$ z. S.A.Aher...

2536 THE CRYSTAL STRUCTURES OF $KMnF_3$, $KFeF_3$, $KCoF_3$, $KNiF_3$ AND $KCuF_3$.
A.Okazaki, Y.Suemune and T.Fuchikami.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1823-4 (Dec., 1959).

Unit-cell dimensions and symmetries are given for the compounds at 298° and 78°K. The first three show a change from cubic ... lower symmetries; the last two remain cubic and tetragonal, respectively. A.R.Stokes

CRYSTAL STRUCTURE OF $KMnF_3$. See Abstr. 2464

2537 CRYSTAL STRUCTURE OF ZIRCONIUM ORTHOPHOSPHATE $Zr_3(PO_4)_4$. A.Burdese and M.L.Borlera.
Ricerca sci. (Italy), Vol. 29, No. 11, 2337-8 (Nov., 1959). In Italian.

The compound is monoclinic, with the following lattice constants: a_0 = 9.16 A; b_0 = 9.11 A; c_0 = 7.92 A; $\beta = 107^\circ 20'$.

ALLOYS . METALLURGY

2538 LATTICE SPACINGS IN THE SYSTEM COPPER + GERMANIUM + SILICON.
J.H.Foley and G.V.Raynor.
Trans Faraday Soc. (GB), Vol. 57, Pt 1, 51-60 (Jan., 1961).

Lattice spacings were measured for the close-packed hexagonal ... ζ-phase in the system copper–silicon, and for the continuous solid solution formed between this phase and the corresponding ζ-phase in the copper–germanium system. In the binary alloys, the a-spac... ing increases with increase in electron/atom ratio, while the c-spacing and the axial ratio decrease; an increase in slope of the curve of a-spacing against electron concentration at approximately 1.4 electrons per atom is consistent with the onset of overlap of electrons in directions at right-angles to the hexagonal axis from the appropriate Brillouin zone at this point. The increase in a is accompanied by a decrease in c such that a^2c remains a linear function of composition throughout the range of homogeneity of the hexagonal phase. In the ternary system, the most striking feature is the constancy of the axial ratio at compositions corresponding to a constant electron/atom ratio. The results obtained are briefly discussed, together with the relationship between the lattice spacings of the face-centred cubic primary solid solution and the a-spacings of the close-packed hexagonal phase with which it enters into equilibrium.

2539 THE THERMODYNAMICS OF THE CHROMIUM–IRON SYSTEM. O.Kubaschewski and G.Heymer.
Acta metallurgica (Internat.), Vol. 8, No. 7, 416-23 (July, 1960).

A method for the determination of the vapour pressure of

chromium has been devised by combining Knudsen's effusion method with tracer analysis using Cr^{51} of half-life 27.8 days. The vapour pressures determined in the temperature range 1170°-1400° C agree with previous work and may be represented by the equation

$$\log p_{atm} = -19\,700/T + 6.92.$$

The heat of sublimation at 298°K is 94.0 kcal/g atom, the boiling point is estimated to be 2680° C. The chromium pressures in the system chromium–iron have been measured at 1340°-1370° C for various compositions. The activity curve shows some positive deviation from Raoult's line. Assuming the solid and liquid solutions to be regular, and using thermal data for the minimum in the liquidus curve and the maximum of the $\sigma-\alpha$ transformation together with Backhurst's atomic heat data for this transformation, the phase boundaries, α–liquid and $\alpha-\sigma$ have been calculated and found to agree essentially with the experimental phase diagram. The solidus–liquidus gap was, however, found to be narrower than hitherto assumed, and the $\alpha-\sigma$ boundary has been extended to lower temperatures.

2540 THE CRYSTALLOGRAPHY OF THE CUBIC TO ORTHORHOMBIC TRANSFORMATION IN THE ALLOY AuCu.
R.Smith and J.S.Bowles.
Acta metallurgica (Internat.), Vol. 7, No. 8, 405-15 (July, 1960).

The habit plane, orientation relationships and shape change associated with the transformation to the ordered orthorhombic phase in the alloy CuAu were measured and are shown to conform with the phenomenological theory of martensitic transformations. The agreement with theory is systematically better when some dilation of the habit plane is permitted. Groups of four plates having an irrational habit close to $\{110\}_C$ develop into compound plates parallel to $\{110\}_C$.

2541 ENERGY OF THE ORDER–DISORDER TRANSFORMATION IN AuCu.
R.L.Orr, J.Luciat-Labry and R.Hultgren.
Acta metallurgica (Internat.), Vol. 8, No. 7, 431-4 (July, 1960).

The heat of formation of AuCu was determined at various temperatures up to 900° K. From these and other data it was possible to establish the energy of disordering as a function of temperature, assuming that, except for the disordering reaction, the heat of formation should be invariant with temperature (Kopp's law). This result is discussed in terms of existing X-ray diffraction measurements of long-range and short-range order parameters for the alloy. Nearly 40% of the energy effect occurs below 658° K, where the X-ray results indicate the long-range order is 97% complete. Before this surprising result is accepted, X-ray measurements of order should be made at high temperature, rather than on quenched alloys. Above the critical temperature indications of the destruction of short-range order are found.

2542 ON THE SUPERSTRUCTURE OF THE ORDERED ALLOY $Au_3Zn[R]$. H. Iwasaki.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1456 (Oct., 1959).

The structures of $Au_3Zn[R]$ and $Au_3Zn[H]$ have been studied by the single crystal oscillation method. A tetragonal structure was found for $Au_3Zn[R]$. This is apparently a thermodynamically stable phase which is formed on the zinc deficient side of the stoichiometric composition. The orthorhombic structure as proposed by other workers has been found on the other side of the stoichiometric composition. There is a close relationship between the two structures and it is proposed that the tetragonal structure may be an anti-phase domain structure of the orthorhombic one. A.E.Kay

OTHER SOLID FORMS

2543 RELATION BETWEEN THE STRUCTURE AND PHYSICAL PROPERTIES OF GLASS. III. THERMAL EXPANSION OF GLASS. I.Náray-Szabó.
Acta phys. Hungar., Vol. 9, No. 4, 403-21 (1959). In German.
For Pt II, see Abstr. 18381 of 1960.

2544 RELATION BETWEEN THE STRUCTURE AND PHYSICAL PROPERTIES OF GLASS. IV. STRENGTH OF GLASS.
I.Náray-Szabó and J.Ladik.
Acta phys. Hungar., Vol. 12, No. 2, 131-8 (1960). In German.

The strength of quartz glass is calculated by an electrostatic argument assuming a Morse potential function for the Si–O bond and calculating the number of such bonds per cm^2 by the method of oxygen ion volumes. The strength comes out to be 2508 kg/mm^2, a little greater than the maximum measured value for quartz glass fibres and considerably greater than the mean. The reasons for this and for the greater strength of thin filaments are discussed and a structural model suggested. R.G.C.Arridge

Surfaces . Films . Adsorption

2545 SURFACE STRUCTURE AND DIFFUSION.
R.Gomer.
Disc. Faraday Soc. (GB), No. 28, 23-7 (1959).

"Crystal imperfections" discussion (see Abstr. of 1961).

Field emission studies of surface diffusion on clean single crystals of known orientation and structure have shown the existence of several modes of surface diffusion for chemisorbed gases. It is found that there is a definite correlation between activation energy and entropy for diffusion on the one hand and surface structure (on the atomic scale) on the other. The ratio of activation energy to heat of binding shows similar behaviour, increasing with increasing roughness. In addition the size and binding mode of the adsorbate plays an important role. These studies illuminate also the well-known changes in heats of adsorption with coverage and indicate that a large fraction of the effect can be attributed to the inherent atomistic inhomogeneity of metal surfaces. Some detailed correlation can be made. Similar results for physical adsorption and multilayer formation are discussed.

2546 METAL OXIDATION AND SURFACE STRUCTURE.
T.B.Grimley.
Disc. Faraday Soc. (GB), No. 28, 223-8 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961).

The chemisorption of oxygen on a thin oxide film on a metal is discussed, and compared with that on the oxide in bulk. If the oxide film is thin, chemisorption of oxygen as ions is larger on the composite system. Oxygen ions account for almost all the chemisorption on n-type oxides, but on p-type oxides the main chemisorption occurs as neutral pairs. In both cases, sufficient oxygen ions are present to give a significant electrical potential difference across the film as is required in Mott's theory of film growth.

2547 ON THE PREPARATION OF EVAPORATED LEAD SELENIDE LAYERS OF HIGH MECHANICAL AND ELECTRICAL STABILITY.
H.Gobrecht, F.Niemeck and K.E.Boeters.
Z. Phys. (Germany), Vol. 159, No. 5, 533-40 (1960). In German.

Details are given for evaporation of single crystal lead selenide and selenium. The electrical conductance is monitored during the evaporation and enables the deposition parameters to be determined. This leads to a technique of preparing PbSe layers which show reproducible properties and high photoconductivity. C.A.Hogarth

2548 STRUCTURE AND AGGREGATION PROCESSES IN EVAPORATED LAYERS OF SILVER AND LEAD.
R.Grigorovici, N.Croitoru and A.Devényi.
Z. Phys. (Germany), Vol. 160, No. 3, 277-90 (1960). In German.

The resistance of layers evaporated on to glass and quartz substrates at liquid N_2 temperatures was measured at different temperatures. The resistance depended on the rate of deposition but asymptoted to a constant value at higher temperatures with both silver and lead. The structural changes of the layers were studied from electron micrographs and are discussed theoretically. J.E.Caffyn

OPTICAL PROPERTIES OF THIN FILMS. See Abstr. 1823

2549 ADSORPTION IN RELATION TO SEMICONDUCTIVITY AND ASSOCIATED PROPERTIES OF SURFACES.
T.J.Gray and S.D.Savage.
Disc. Faraday Soc. (GB), No. 28, 159-67 (1959).

"Crystal imperfections" discussion (see Abstr. of 1961).

Previous work on the adsorption and desorption of oxygen on thin oxide films has led to the establishment of qualitative relationships between the electronic constitution of the surface as measured by the conductivity and the quantity of gas adsorbed. A study of the rates of change of conductivity of thin oxide films and pressure of

the adsorbing gases led to a formulation of the kinetics involved in adsorption and desorption. This work is extended to yield a quasi-quantitative relationship between the amount of gas adsorbed, the fraction of surface covered, and the numbers of free current carriers produced. The kinetics were studied in a more rigorous manner in an effort to evaluate reaction constants and apparent activation energies for both the initial adsorption step and subsequent electronic rearrangements. As a further aid in evaluating the electronic constitution of the surface and in studying its change during adsorption, preliminary measurements of contact potential differences are being performed under varying conditions of illumination. It is believed that, by this treatment, it will be possible to develop a more rigorous and comprehensive theory of chemisorption and catalysis based on a complex barrier layer than is possible by the oversimplified treatment of Hauffe and others.

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

2550 INVESTIGATION OF THE SUB-MICROSCOPIC STRUCTURE OF SLIGHTLY ABSORBING MATERIALS BY A METHOD OF MULTIPLE SMALL-ANGLE SCATTERING OF X-RAYS. G.M.Plavnik and B.M.Rovinskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 6, 1099-1106 (June, 1960). In Russian.

The method involves comparative measurements of X-ray intensity with the specimen located in a scattering and a non-scattering position in the X-ray beam. The theory of the method is developed and the results are reported for beryllium oxide. The estimated pore size agrees fairly well with that obtained from the usual small-angle scattering method. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

2551 X-RAY MEASUREMENT OF GRAIN SIZE. B.E.Warren.
J. appl. Phys. (USA), Vol. 31, No. 12, 2237-9 (Dec., 1960).

When the number of crystals contributing to a powder pattern peak is small, changes in the position and orientation of the sample produce statistical variations in the measured integrated intensity. The statistics are those of a Poisson distribution, and the effect can be utilized in a very simple way for an absolute determination of grain size. Only relative intensity measurements are required. Grain sizes down to about one or two microns can be measured by this method. There is an interesting possibility of varying the experimental conditions in such a way as to distinguish between the sizes of grains and subgrains.

2552 A NEW DEVICE FOR MEASURING THICKNESS OF EVAPORATED METAL FILM BY USE OF X-RAY INTERFERENCE FRINGES. Y.Fujiki and T.Yoshida.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1828 (Dec., 1959).

A modification of Keissig's method (see Abstr. 8805 of 1958, 5788 of 1959) is described, in which a comparatively broad source of X-rays can be used. A.R.Stokes

2553 A NEW SHADOWING MATERIAL FOR ELECTRON MICROSCOPY. A.P.Murphy and J.F.Goodman.
Nature (GB), Vol. 188, 689-90 (Nov. 19, 1960).

Osmium oxide, prepared by mixing dilute aqueous solutions of osmium tetroxide and ferrous sulphate, can be evaporated from a tungsten ribbon in vacuo. It forms an amorphous film which shows much less structure in the electron micrograph than does platinum, when used for shadowcasting fine crystals of sodium laurate on a carbon film. The residual granularity is ascribed to the carbon substrate. V.E.Cosslett

2554 ELECTRON OPTICAL STUDIES OF IMPERFECT CRYSTALS AND THEIR SURFACES.
G.A.Bassett, J.W.Menter and D.W.Pashley.
Disc. Faraday Soc. (GB), No. 28, 7-15 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). The preparation of simple reproducible single-crystal surfaces by direct growth, electropolishing, vacuum evaporation and cleavage is first considered. It is shown that the step structure of some cleavage surfaces may be studied by a "decoration replica" technique which reveals all steps down to those of unit atomic height. Single-crystal cleavage-surfaces may be used as substrates on which to grow thin single-crystal metal-films. After detaching from the substrate these films may be studied in the transmission electron microscope. Their defect structure (dislocations, etc.) may be characterized either by diffraction contrast effects or by means of moiré patterns formed by superposing two films. These films may be used as starting materials for studies of a variety of nucleation and growth phenomena occurring at surfaces, in order to determine, for example, whether the termination of a dislocation line is a preferred site. Preliminary results on the very early stages of the electrodeposition of nickel on gold and the oxidation of copper are described.

2555 ELECTRON MICROSCOPE STUDIES OF COLLOIDS IN KCl. R.E.Simon and R.L.Sproull.
J. appl. Phys. (USA), Vol. 31, No. 12, 2224-5 (Dec., 1960).

Electron microscope studies were made of surfaces of potassium chloride crystals containing excess potassium. The crystals were cleaved in a vacuum and the surfaces replicated in the same vacuum. Large potassium colloids were observed with distinctive shapes and orientations determined by the host lattice.

PHYSICAL CHEMISTRY

THERMOCHEMISTRY . REACTIONS

2556 PRECIPITATION REACTIONS IN CRYSTALS OF SILVER AND ALKALI HALIDES. J.W.Mitchell.
Disc. Faraday Soc. (GB), No. 28, 242-7 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). The mechanisms involved in the separation of particles of colloidal metal during photochemical and chemical reactions in crystals of silver and alkali halides are discussed. In the silver halides, in which the lattice disorder is of the Frenkel type, the particles appear mainly along the dislocation lines where the nuclei upon which they develop must therefore be formed. The compressive stress fields which are established around the particles during their subsequent growth are relaxed by the formation of systems of prismatic dislocations. In the alkali halides, the lattice disorder is of the Schottky type. During precipitation reactions in which particles of gold separates nuclei may be formed both within elements of the substructure and along dislocation lines. The compressive stress fields which arise during the growth of the particles are relaxed by the creation of prismatic dislocations and by the condensation of Schottky defects at the interface between the particles and the alkali halide.

2557 ON THE REACTION OF ACTIVE NITROGEN WITH ATOMIC HYDROGEN.
H.Guenebaut, G.Pannetier and P.Goudmand.
C.R. Acad. Sci. (France), Vol. 251, No. 15, 1480-2 (Oct. 10, 1960). In French.

The active gases are produced by high voltage discharge and the reaction is followed spectroscopically. Various energy states of N_2 and the $^3\Pi$–$3\Sigma^-$ states of NH are among the systems detected. A theoretical interpretation is proposed. G.I.W.Llewelyn

CHEMICAL REACTIVITY OF SOLIDS. See Abstr. 2386

PHOTOCHEMISTRY
RADIATION CHEMISTRY

2558 THE PHOTOLYSIS OF BARIUM AZIDE IN THE SOLID STATE. P.W.M.Jacobs, F.C.Tompkins and D.A.Young. Disc. Faraday Soc. (GB), No. 28, 234-41 (1959).

"Crystal imperfections" discussion (see Abstr. 2386 of 1961). Kinetic measurements of the dependence of the rate of evolution of nitrogen from barium azide on the intensity of radiation, the extent of decomposition and the nature of the light source, show the reaction to be more complex than was previously indicated. A modified mechanism of the photolytic reaction, involving the production and reaction of both excitons and positive holes, is formulated.

2559 METHYL AFFINITIES DETERMINED BY PHOTOLYSIS OF AZOMETHANE. C.Steel and M.Szwarc. J. chem. Phys (USA), Vol. 33, No. 6, 1677-80 (Dec., 1960).

The thermal decomposition of acetyl peroxide forms acetate radicals which decarboxylate into methyl radicals. The reaction products may result, therefore, either from methyl radicals or from acetate radicals which decarboxylate simultaneously as they interact with the substrate. To identify the reacting species, reactions previously investigated in an acetyl peroxide system were reinvestigated using the photolysis of azomethane as the source of radicals. The results prove that at least in hydrocarbon solvents methyl radicals, and not acetate radicals, are the reacting species in the acetyl peroxide system. Furthermore, it is shown that photolysis of azomethane in solution provides a clean and simple system to study reactions of methyl radicals.

DISPERSIONS . COLLOIDS

2560 MEASUREMENT OF PARTICLE SIZES BY HIGHER ORDER TYNDALL SPECTRA (θ_1 METHOD). S.Kitani. J. Colloid Sci. (USA), Vol. 15, No. 4, 287-93 (Aug., 1960).

Particle size measurements by higher-order Tyndall spectra have been developed. In a previous experiment (1956) it was found that the first angle, θ_1, which is measured from the direction of propagation of the incident beam, of red spectra of higher order Tyndall spectra is related to the average particle size, $\bar{r}$. These relations are discussed from the theoretical standpoint. The average radius of a monodisperse aerosol consisting of spherical particles can be evaluated by measuring θ_1 from the following equation, independent of refractive index except for the value of 2.0:

$$\log (\theta_1/10) + 1.43 \log (10\,\bar{r}) = 1.43,$$

where θ_1 is in degrees of arc and $\bar{r}$ in microns.

ATTACHMENT OF RADIOACTIVE ATOMS ON AEROSOLS (SUSPENDED CHEMICAL AGENTS) IN THE SIZE RANGE 0.7-5 μ (RADIUS). See Abstr. 2179

ELECTRON MICROSCOPE STUDIES OF COLLOIDS IN KCl. See Abstr. 2555

PHYSICAL METHODS OF CHEMICAL ANALYSIS

2561 RECORDING INTEGRATOR FOR GAS CHROMATOGRAPHY. A.P.H.Jennings. J. sci. Instrum. (GB), Vol. 38, No. 2, 55-8 (Feb., 1961).

An automatic integrator is described based on the velodyne principle, whereby a motor is caused to run at a speed proportional to the signal to be integrated. The total number of revolutions of the motor in a given period is proportional to the time integral during this period. The integral is recorded continuously in analogue form on the same chart as the input signal. The basic units are standard commercial items and relatively simple additional circuitry gives a flexible control system. The accuracy obtainable is of the order of 0.5%.

GEOPHYSICS

ATMOSPHERE

(Troposphere and Stratosphere)

2562 ATMOSPHERIC DIFFUSION. A.S.Monin.
Uspekhi. fiz. Nauk (USSR), Vol. 67, No. 1, 119-130 (Jan., 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 2, No. 1, 50-58 (Jan.-Feb., 1959).

Review. Discusses causative factors, the equations of turbulent diffusion, limiting rates of turbulent diffusion and diffusion in large-scale turbulence. Suggestions are given for future research. N.Curle

2563 CONVENTION ON ACTINOMETRY AND ATMOSPHERIC OPTICS. K.Ya.Kondrat'ev and G.V.Rozenberg.
Uspekhi fiz. Nauk (USSR), Vol. 68, No. 2, 345-58 (June, 1959). In Russian. English translation in: Soviet Physics—Uspekhi (USA), Vol. 68(2), No. 3, 481-95 (May-June, 1959).

Held in Leningrad, from 28 January to 4 February 1959. One hundred and two papers were presented on the following subjects: (1) Radiation balance and its components. (2) Brightness and polarization of the daylight and dusk sky. (3) Transparency of the atmosphere. (4) Study of the atmospheric aerosol by optical methods. (5) Reflectivity of the earth's surface. (6) Theory of radiation transfer in the atmosphere. (7) Methods of actinometric measurements. (8) Radiation and its structure.

2564 DIFFUSE TRANSMISSION OF SOLAR ULTRAVIOLET RADIATION IN THE PRESENCE OF OZONE. Z.Sekera and J.V.Dave.
Astrophys. J. (USA), Vol. 133, No. 1, 210-27 (Jan., 1961).

The problem of diffuse transmission of solar ultraviolet radiation in the presence of ozone absorption has been solved theoretically. The plane-parallel atmosphere is divided into two layers. Ozone is assumed to be distributed according to photochemical theory in the upper layer, whose scattering optical thickness is small, and hence only primary scattering is taken into consideration in this layer. The scattering optical thickness of the lower layer is large, and hence all the orders of scattering have been considered. However, it is assumed that there is no ozone in the lower layer. It is shown that the intensity of skylight received at the bottom of the atmosphere consists of seven different components originating strictly from the upper or lower layer as a consequence of illumination by direct solar radiation or as a result of diffuse illumination of one layer by the other. The results of computations for the direction of observation toward the zenith are presented for several positions of the sun and for several absorption optical thicknesses of the upper layer. The effect of multiple scattering on the observed "umkehr" curve, used in the determination of vertical distribution of ozone from ground stations, is also discussed.

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

2565 INTERNATIONAL SYMPOSIUM ON FLUID MECHANICS IN THE IONOSPHERE.
J. geophys. Res. (USA), Vol. 64, No. 12, 2037-2238 (Dec., 1959).

For abstracts of the papers presented at the above symposium see Abstr. 10486, 10640, 12152-5, 12157, 12161-5, 12167-76, 12184-5, 12406, 14196, 14318 and 21388 of 1960.

2566 ANISOTROPY IN IONOSPHERIC DIFFRACTION AND ITS EFFECT ON DRIFT MEASUREMENT. R.B.Banerji.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 959-68 (Dec., 1960).

An attempt was made by the author a few years ago to combine the geometrical approach of Pütter and the statistical approach of Briggs and Spencer to the problem of ionosphere drift measurement. The combination gave rise to a method of wind measurement which was nearly as simple as that of Pütter and yet vigorous enough to eliminate the effect of random changes in the ground diffraction pattern. However, the method could not be proved valid when the ground pattern was statistically anisotropic. The present paper develops a method involving the use of five statistical parameters and a few simple algebraic formulae, which takes into account the effects of random motion as well as anisotropy. The intuitive clarity of the geometrical picture is, however, unfortunately lost.

2567 OBSERVATIONS OF EARTH–IONOSPHERE CAVITY RESONANCES. M.Balser and C.A.Wagner.
Nature (GB), Vol. 188, 638-41 (Nov. 19, 1960).

Careful observations of extremely low frequency atmospheric radio noise (5-35 c/s) made on June 27-8,1960 at Lincoln Laboratory have revealed a power spectrum with a maximum at 7.8 c/s and several successive smaller maxima at higher frequencies. This is in keeping with the theory of resonant modes for the concentric spherical cavity bounded by the earth and the lower region of the ionosphere. Moreover, the application of the theory to the derivation of the fundamental frequency from the higher modes yields values greater than 7.8 c/s, in agreement with the higher Q (and hence smaller downward shift of the resonant frequency) appropriate to the higher modes. G.M.Brown

2568 FORMATION OF THE SPORADIC E LAYER IN THE TEMPERATE ZONES. J.D.Whitehead.
Nature (GB), Vol. 188, 567 (Nov. 12, 1960).

Points out that the connection between the fraction of time foEs exceeded 5 Mc/s and the horizontal component of the earth's magnetic field (Abstr. 21358 of 1960) is consistent with Es formation arising from a vertical gradient of horizontal movement of the neutral air. G.M.Brown

SIMULTANEOUS OBSERVATIONS OF PULSATIONS IN THE GEOMAGNETIC FIELD AND IN IONOSPHERIC ABSORPTION.
See Abstr. 2577

2569 EARTH SATELLITE OBSERVATIONS AND THE UPPER ATMOSPHERE. TEMPERATURE INVERSION IN THE F1-LAYER. W.Priester and H.A.Martin.
Nature (GB), Vol. 188, 200-2 (Oct. 15, 1960).

Observational data from 1958 δ 2 (Sputnik 3) and 1959 ξ (Discoverer 6) are applied to examine the bend in the curve of log (atmospheric density) against height in the region 150-200 km. Seasonal effects were eliminated and the data for heights above 180 km were corrected to a standard value of solar activity based on a flux of 20 cm solar radiation. The density–height curve from these data and from two rockets confirms the form of the bend in the 180-200 km levels and shows higher densities by day than by night down to at least 200 km. The authors discuss reasons and the possible existence of similar effects at E and F2 layer levels. J.M.Stagg

2570 EARTH SATELLITE OBSERVATIONS AND THE UPPER ATMOSPHERE. DIURNAL AND SEASONAL DENSITY VARIATIONS IN THE UPPER ATMOSPHERE. W.Priester, H.A.Martin and K.Kramp.
Nature (GB), Vol. 188, 202-4 (Oct. 15, 1960).

The discussion of atmospheric densities deduced from satellites 1958 δ 2 (Sputnik 3), 1958 β 2 (Vanguard 1) and 1959 α 1 (Vanguard 2) (see preceding abstract) is extended to the daily and seasonal variations of density at 210, 562 and 660 km. For each of these altitudes curves are given of density against true local time and for different values of $\Delta\delta = \delta_\pi - \delta_\odot$. At 210 km the peak density is at true local noon; at the two greater heights it is at 14 hr, with a minimum at sun rise. The amplitude of the variation is only a few percent at 210 km, but increases with increasing altitudes. A composite figure shows the variation of density with local time at heights up to 700 km. A suggested explanation of the effect is given in terms of heating by the solar He^+ line (304 A) and low conductivity at low heights, and by solar ultraviolet and high conductivity above 300 km. J.M.Stagg

2571 SYSTEMATIC MOVEMENTS OF AURORA AT HALLEY BAY. S.Evans.
Proc. Roy. Soc. A, Vol. 256, 234-40 (June 21, 1960).
"Halley Bay Expedition" (see Abstr. 18476 of 1960). All-sky photographs taken at the Royal Society Base (Halley Bay, Antarctica during the I.G.Y. were used to determine the movement of individual auroral features, on the assumption of a fixed height of occurrence. The movements are spread over a limited range of directions at any instant. A plot of the hourly mean vector movement reveals a systematic diurnal component, reaching a few hundred metres per second in the easterly and westerly directions. The phase and orientation of this component are compared with the horizontal magnetic disturbance vector averaged over the same period and an association is noted which implies effective transport of negative charge by the aurora.

2572 AURORAL RESULTS FROM HALLEY BAY [ANTARCTICA] DURING THE INTERNATIONAL GEOPHYSICAL YEAR. G.M.Thomas.
Proc. Roy. Soc. A, Vol. 256, 241-2, 242-4 (June 21, 1960).
"Halley Bay Expedition" (see Abstr. 18476 of 1960).

2573 AURORA AND AIRGLOW OBSERVATIONS ON FEBRUARY 11, 1958. M.Huruhata.
Rep. Ionosphere Res. Japan, Vol. 12, No. 1, 40-1 (March, 1958).
The display was observed between 1800 and 2230 hr JST in much of the northern part of Japan as a quiet homogeneous arc which at the time of maximum intensity (1930-1950 hr) had several columns of ray structure. An all-sky camera showed a general East–West drift of the brighter features. A partrol spectrograph operating from 1855-2230 hr showed a great enhancement of the 6300 A and 6364 A O I lines and very little enhancement of the 5577 A O I line. R.W.Nicholls

2574 ON THE ENHANCEMENT OF THE LINE (OI) 6300 IN THE AURORA AT NIIGATA ON FEBRUARY 11, 1958. T.Hikosaka.
Rep. Ionosphere Res. Japan, Vol. 12, No. 4, 469-71 (1958).
Spectra of the aurora photographed at f/0.7 indicate an intensity ratio of 20 between the λ 6300 and λ 5577 A O I lines. This observation is not capable of interpretation as a cascade transition mechanism. Some selective excitation of the ^1D level appears to be operative. R.W.Nicholls

2575 INTEGRATED STARLIGHT OVER THE SKY. F.E.Roach and L.R.Megill.
Astrophys. J. (USA), Vol. 133, No. 1, 228-42 (Jan., 1961).
Calculations are made of the total integrated starlight over the entire sky based on the star counts in Groningen Publication, No. 43 (van Rhijn 1925). The results are given in both the photographic and the visual magnitude scales in tabular and graphical form.

2576 THE ACCELERATION OF PARTICLES IN THE OUTER ATMOSPHERE. T.Obayashi.
Rep. Ionosphere Space Res. Japan, Vol. 13, No. 2, 123-5 (June, 1959).
It is suggested that the mechanism of production of high-energy particles in the van Allen belts may be Fermi acceleration of particles in regions of plasma agitated by hydromagnetic waves. The positions of the zones in which such particles would be expected are calculated and reasonable agreement is found with the actual positions of the van Allen belts. D.M.Schlapp

GEOMAGNETISM

2577 SIMULTANEOUS OBSERVATIONS OF PULSATIONS IN THE GEOMAGNETIC FIELD AND IN IONOSPHERIC ABSORPTION. S.Ziauddin.
Canad. J. Phys., Vol. 38, No. 12, 1714-15 (Dec., 1960).
Regular pulsations of cosmic noise absorption and horizontal field components were observed during September 1959 at Saskatoon. The variations were often in phase but sometimes in antiphase. The observed periods are consistent with the theory which ascribes magnetic pulsations to toroidal hydromagnetic oscillations of the outer atmosphere. G.M.Brown

SOLAR ACTIVITY AND GEOMAGNETIC STORMS, 1959. See Abstr. 1643

GEOMAGNETIC FIELD MEASUREMENTS: RECOMMENDED VALUE OF PROTON GYROMAGNETIC RATIO. See Abstr. 2051

COSMIC-RAY INTENSITY VARIATIONS DURING MAGNETIC STORMS. See Abstr. 2149

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

Hearing . Speech

2578 COMPUTER IDENTIFICATION OF VOWEL TYPES. J.D.Foulkes.

J. Acoust. Soc. Amer., Vol. 33, No. 1, 7-11 (Jan., 1961).

In a classical study of the vowel sounds of English, Peterson and Barney (Abstr. 3407 of 1952) collected a large body of experimental data which related perceived vowel quality to measurements of the first three formant frequencies and the voice pitch. It is difficult for a computer to use this raw data to interpret vowel quality because the vowel types have complicated boundaries in the coordinate system of the physical measurements. A coordinate transformation is described which simplified these boundaries.

Vision

2579 ON THE PRESENT STATE OF PHYSIOLOGICAL OPTICS. H.Schober.

"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 132-49. In German.

A review of a restricted number of topics [which appears in some ways to be out of date] . R.A.Weale

2580 IS RESEARCH ON BIOLOGICAL OPTICS STILL TOPICAL? K.Mutze.

"Optics of all wavelengths" Meeting, Jena, 1958, (see Abstr. 224 of 1961) p. 150-62. In German.

A review of the perceptual aspects of vision with special reference to (superb) optical illusions. R.A.Weale

TECHNIQUE . MATERIALS

2581 INEXPENSIVE SAFETY SWITCH FOR WATER-COOLED EQUIPMENT. R.Hawley.

Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1352-3 (Dec., 1960).

Describes a switch that cuts off the electrical supply to heaters should the cooling water pressure fall to a certain minimum or zero. The device depends on a spring loaded plate pressing against a plastic hose which supplies the water; it does not indicate flow rate. R.Hawley

2582 LEVELING SYSTEM FOR LIQUID NITROGEN. S.Leefe and N.Liebson.

Rev. sci. Instrum. (USA), Vol. 31, No. 12, 1353-4 (Dec., 1960).

The device uses a cold solenoid valve and a phase separator, and will hold the level of liquid nitrogen within $\pm \frac{1}{16}$ in. Operation is completely automatic and can be maintained for prolonged periods of time.

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Vol. 64 (1961). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free. The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

AEI Engng (GB)	AEI Engineering (Formerly: AEI Engineering Review). Associated Electrical Industries, 33 Grosvenor Place, London, S.W.1.
Acero y Energia (Spain)	Acero y Energia C. Berlin 46-50, Barcelona 15.
Elect. Commun. Lab. tech. J. (Japan)	Electrical Communication Laboratory Technical Journal Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Tokyo.
Electro-Technology (USA)	Electro-Technology (Formerly: Electrical Manufacturing) C-M Technical Publications Corporation, 305 East 42 Street, New York 17, N.Y.
Jodrell Bank Ann. (GB)	Jodrell Bank Annals (Astronomical Contributions from the University of Manchester, Series 1) Jodrell Bank Experimental Station, Lower Withington, Macclesfield, Cheshire.
Materials Res. Stand. (USA)	Materials Research and Standards (Formerly: American Society for Testing Materials. Bulletin) American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.
Mem. Fac. Engng Hiroshima Univ. (Japan)	Memoirs of the Faculty of Engineering, Hiroshima University Hiroshima.
Phys. Metals and Metallography (GB)	Physics of Metals and Metallography Pergamon Press, Headington Hill Hall, Oxford, England; 122 East 55th Street, New York 22, N.Y. [A translation of Fizika Metallov i Metallovedenie].

NEW JOURNAL

Mem. Fac. Engng Osaka City Univ. (Japan)	Memoirs of the Faculty of Engineering, Osaka City University Nishiogimachi, Kitaku, Osaka. Annual. Vol. 1 dated December, 1959.

CHANGE OF TITLE

AEI Engng Rev. (GB)	AEI Engineering Review Title changed to: AEI Engineering [AEI Engng] with issue dated Vol. 1, No. 1, Jan., 1961.
ASTM Bull. (USA)	American Society for Testing Materials. Bulletin Title changed to: Materials Research and Standards [Materials Res. Stand.] with issue dated Vol. 1, No. 1, Jan., 1961.
Elect. Manufng (USA)	Electrical Manufacturing Title changed to: Electro-Technology with issue dated Vol. 66, No. 5, 1960.

NOTE

Fiz. Metallov i Metallovedenie (USSR)	Fizika Metallov i Metallovedenie Izdatel'stvo Akademii Nauk SSSR, Sverdlovsk. [A translation is published as: Physics of Metals and Metallography].

ERRATA

Abstr. 7336 (1960) line 4: for "1614" read "1614-15"
Abstr. 16411 (1960) line 8: for "introduction type" read "induction type"
Abstr. 19329 (1960) line 3: delete "In German"
line 16: for "desirable" read "undesirable"
Author Index (Déc., 1960): delete "Eklund,K., 19597", insert "Patrakhin,N.P., 19597"
Abstr. 176 (1961) line 2: for "F.A.Mason" read "E.A.Mason"
Abstr. 494 (1961) line 2: for NUCLEAR" read "NUCLEON"
Abstr. 1585 (1961) line 2: for "W.H.Cambell" read "W.H.Campbell"
Abstr. 2099 (1961) line 6: for "M.I.Soloviev" read "M.I.Solov'ev"

AUTHOR INDEX

Physics Abstracts

welcomes applications from physicists willing to offer their services as

Abstractors

Expert knowledge of some branch of modern physics is required (of research standard) and it is desirable to have a reading knowledge of at least one foreign language, particularly

Russian or German

The articles and books abstracted can be retained by the abstractors, and fees are paid for all abstracts published (foreign articles at a higher rate).

Apply to

Science Abstracts
The Institution of Electrical Engineers
Savoy Place, London, W.C.2

THE INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY PUBLICATIONS

PROCEEDINGS OF THE PHYSICAL SOCIETY
Published monthly, price £12 12s. per annum.

REPORTS ON PROGRESS IN PHYSICS
Containing Articles of a review nature, surveying the present state of knowledge in various fields of physics. *Published annually in the Spring, price £3 3s. (Articles are also available separately.)*

HANDBOOK OF SCIENTIFIC INSTRUMENTS AND APPARATUS
The Handbook is published in connection with the Physical Society Exhibition, and forms an invaluable guide to the most recent developments in scientific equipment.
Published annually, price 6s.

BRITISH JOURNAL OF APPLIED PHYSICS
Published monthly, price £6 per annum.

JOURNAL OF SCIENTIFIC INSTRUMENTS
Published monthly, price £6 per annum.

PHYSICS IN INDUSTRY SERIES
Published at irregular intervals.

STUDENT MONOGRAPHS
Published at irregular intervals, price 6s.

Orders to:

THE INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

47, Belgrave Square, London, S.W.1

1960–1961

Committee of Management

THE INSTITUTION OF ELECTRICAL ENGINEERS

The President (*ex officio*)
L. Hartshorn, D.Sc., M.I.E.E.
R. W. Sillars, B.A., D.Phil., M.I.E.E.
R. L. Smith-Rose, C.B.E., D.Sc., Ph.D., M.I.E.E.
H. G. Taylor, D.Sc.(Eng.), M.I.E.E.

THE INSTITUTE OF PHYSICS AND THE PHYSICAL SOCIETY

J. H. Awbery, M.A., B.Sc. (*Chairman*)
W. R. S. Garton, B.Sc.
D. Roaf, M.A., D.Phil.
Miss A. C. Stickland, M.Sc., Ph.D.
L. R. G. Treloar, B.Sc., Ph.D., D.Sc., F.Inst.P.

THE ROYAL SOCIETY

W. C. Price, Sc.D., F.R.S.

THE CENTRAL ELECTRICITY GENERATING BOARD

H. W. Gatehouse, A.M.I.E.E.

OBSERVER FOR THE AMERICAN PHYSICAL SOCIETY

T. H. Osgood, Ph.D.

Editorial

EDITOR

B. M. Crowther, M.A., Ph.D., F.Inst.P.

SECTION EDITOR (Physics)

H. Jenkins, B.Sc., A.Inst.P.

SECTION EDITOR (Electrical Engineering)

L. MacQuisten Wallace, B.Sc., A.M.I.E.E., A.M.I.E.(Aust.)

ASSISTANT EDITORS (Physics)

J. R. Day, B.Sc.
N. R. Fowler, A.R.C.S., D.I.C., F.Inst.P.
A. M. Lever, M.A.
T. B. Wright, B.Sc., A.R.C.S.

ASSISTANT EDITOR (Electrical Engineering)

J. J. Mulroy, B.Sc.

Annual Subscriptions

Science Abstracts is published in two sections, available separately:

Section A, *Physics Abstracts*	£10 0 0
Section B, *Electrical Engineering Abstracts*	£7 0 0
Both sections	£16 0 0

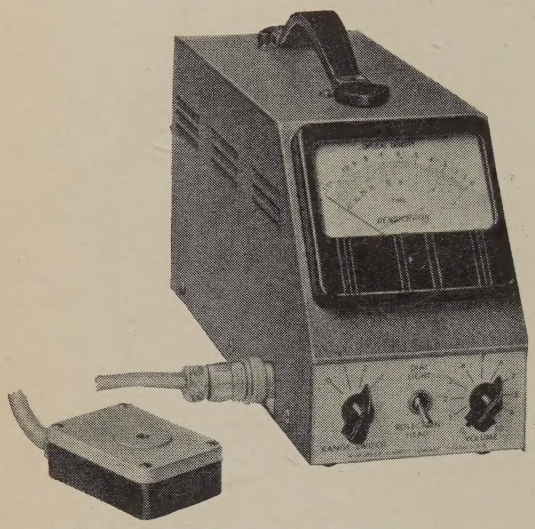
THE INSTITUTION OF ELECTRICAL ENGINEERS,
Savoy Place, London, W.C.2 *Telephone:* Covent Garden 1871

A Versatile Instrument for the Measurement of Reflectance and Transmittance

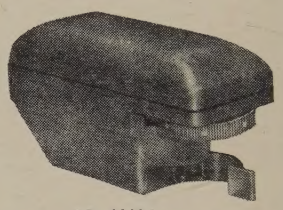
Welch DENSICHRON®

ELECTRONIC DENSITOMETER

- *Good Sensitivity*
- *High Stability*



NO. 3830A DENSICHRON AND PROBE



REFLECTION UNIT

NO. 3832A

— SPECIAL FEATURES —

Patented Magnetic Modulation

Simple to use

Convenient Small Size—5 x 7¼ x 13 inches

Light in Weight—only 11½ pounds

No. 3830A. DENSICHRON WITH BLUE PROBE, including amplifier with logarithmic scale meter, metal probe support, 3 different measuring apertures, a cone with ⅛ inch aperture and a set of instructions. The amplifier operates on 115 volts, 60 cycle, A.C. only except on special order.

Each, $250.00

No. 3830B. DENSICHRON WITH RED PROBE

Each, $265.00

No. 3832A. REFLECTION UNIT. When coupled to the Densichron amplifier this unit becomes a convenient reflectance meter. It has a self-contained convenient reflectance filter wheel and phototube, and includes optics for both small and large spot work, a calibrated gray scale, and three Carrara working standards.

WRITE FOR OUR DENSICHRON CATALOG

THE WELCH SCIENTIFIC COMPANY

ESTABLISHED 1880

1515 SEDGWICK STREET, DEPT. PA, CHICAGO 10, ILLINOIS, U.S.A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

PRINTED BY UNWIN BROTHERS LIMITED, WOKING AND LONDON